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NEW YORK, MAY, 1887.

THE office of the RAILROAD AND ENGINEERING JOURNAL is now at No. 45 Broadway, New York, having been removed from No. 23 Murray Street on May 1. All communications for the JOURNAL, its proprietor, or its editors should be addressed to No. 45 Broadway, New York.

IT is reported that a number of prominent railroad companies have agreed to unite in a scheme for selecting one automatic coupler for general use. The companies which have joined in the plan will appoint representatives, who will recommend some one coupler, and the companies all agree to adopt whatever coupler is thus recommended. Probably this is the only way that any agreement can ever be reached on this point.

THE discussion of Mr. Metcalf's paper on Steel in the American Society of Civil Engineers, was one of the most extended which has been called out by any paper presented for a long time past. This discussion took a wide range. and served to show the general interest in the question—and also to show how great the differences of opinion are among engineers as to the uses of steel, and how much uncertainty there is with many, as to its true nature and the best methods of dealing with it.

ONE notable feature of the discussion was the great attention paid to the use of steel for guns. Mr. Metcalf's paper dealt with this question, it is true, but gun steel was not the only, nor indeed the chief subject of which he wrote. Nevertheless gun steel was the subject chiefly spoken of in the discussions, and the question of steel for bridges and other structural uses, took up but a small part of the time. That the naval officers who joined in the discussion should treat of guns alone was, of course, to be expected, but the amount of attention paid to them by the engineers was somewhat remarkable.

SOME progress is to be recorded in naval matters during the past month. The contracts for the steel armor-plates for vessels now under construction and for the steel forgings for heavy guns, which have been pending for some months, have been let to the Bethlehem Iron Company. That company was not only the lowest bidder, but it had also made such progress in erecting the necessary plant for handling heavy masses of steel that it was able to promise delivery of both the plates and forgings at an earlier date than any of its competitors. That such heavy plants have not heretofore existed in this country is not be taken as any reflection on the enterprise of our steel-makers; it is simply due to the fact that heretofore the demand for heavy plates and forgings, which has been created abroad by government calls for land and naval armament, has not existed here. It is also to be remembered that a continuance of this demand for military purposes can be relied on in England, France and Germany, while its duration here is very uncertain.

The Navy Department, as noted elsewhere, has issued proposals for several of the new vessels whose construction has been authorized by Congress, and is now awaiting bids from contractors.

The plans for two of the large vessels authorized—an armored cruiser and an armored battle-ship—have been handed in and are under consideration by a mixed board of naval officers and civilian constructors.

All of these things indicate progress, and it is encouraging to note that there is an evident intention on the part of the naval authorities that this progress shall be intelligently directed, and the additions to the Navy shall be of as permanent value as possible.

THE investigation of the Bussey Bridge accident by the Massachusetts Railroad Commissioners has resulted in an elaborate report which is not yet submitted to the Legislature as we go to press. It is said, however, that the Commissioners, after carefully considering the evidence, are of opinion that there was no derailment of the train before it reached the bridge, and no accident or breakage of the train or the bridge which could have accounted for its fall. They believe that the accident was caused by the simple failure of the bridge, which had reached a point where, owing to original structural weakness and long wear, it was no longer able to carry the loads put upon it.

The Massachusetts Commission has always been very careful in its investigations and findings in accident cases, and its decisions have accordingly had mnch weight. That there was much testimony of an uncertain and contradictory character is true, but this is almost always the case in such inquiries, and simply shows that the present one was no exception to the general rule.

NARROW-GAUGE lines continue to diminish rapidly in number. During the past month the Jacksonville, Tampa & Key West Company, in Florida, changed a branch of 30 miles from 3 ft. to standard gauge, and the Dayton & Ironton road, of 167 miles, in Ohio, was changed April 3. The Havana, Rantoul & Eastern, one of the longest narrow-gauge lines in Illinois, has passed into the hands of the Illinois Central Company and is to be changed as soon as arrangements can be made.

At this rate there will be only a few isolated local lines of the narrow-gauge left in the United States, outside of the mountain lines in Colorado and Utah, and it is not im-

probable that these will follow the prevailing movement towards uniform gauge as their business increases.

THE recent agitation of the question of rapid transit in New York City, and the need of additional facilities for the movement of passengers, has developed a new public interest in the matter. So far as public opinion has found expression, it would seem to favor elevated rather than underground lines, although the latter find many advocates. There is a very decided feeling, however, that any grants of new privileges should be very carefully made, and should be entirely independent of existing corporations. At present, it seems probable that nothing will be done this year.

THE article published in another column on "Bridges and Steam Ferries in India," is of interest in showing by inference how railroad practice in that country has almost exactly reversed our own. The first railroads in India were modeled on the English lines and were very solidly and expensively built, but experience has taught Indian engineers that, with the exception of a few important lines of traffic, such roads could not be expected to return interest on their cost, and there has been a gradual reversal of the original methods and a substitution of a cheaper style of road. The old methods still survive to some extent, however, and in the last year or two some very expensive works have been undertaken.

River crossings have always been among the most difficult problems with which engineers in India have had to deal, and there are probably few countries in the world with an equal mileage of railroad which have more large and costly bridges. More than one of these, as the paper referred to claims, could well have been dispensed with, and the capital applied to the building of needed branches and extensions.

The arguments brought forward by the writer, with the exception of those based upon military necessity, will not seem novel in this country, where the steam ferry for the transfer of cars is so frequently used that its employment seems to be a matter of course, and it is only when the traffic becomes heavy enough to warrant it, or where circumstances are especially favorable, that the question of building a bridge is considered at all.

STANDARD RAIL SECTIONS.

THE great diversity in the forms of rail-sections has been a subject of lament by railroad engineers and rail manufacturers for many years past. Various efforts have been made to secure the adoption of standard forms, but thus far without avail. Most young engineers, when first placed in charge of a line of railroad, feel that their careers and their reputations will not be assured unless they first design one or more new forms of rail sections, which they fondly believe and assert are better than any other form ever devised. The present diversity of forms is a consequence, in part, of their ambitious efforts. While this great variety is to be regretted, there can be no doubt that the present and past state of the art is and has been a condition of evolution, and that the forms of sections have been slowly improved, although every change which hss been made has not always been in the direction of progress. It is very obvious, though, that if at any time during the past ten, twenty or thirty years, a standard system of rail-sections had been adopted that their design would now be antiquated. At present, as in the past, general agreement in any forms of sections seems hopeless. Before people will agree they must think alike, but, as error assumes countless forms, our only hope of agreement in this case, as in many others, is from an increase of knowledge which will lead to right

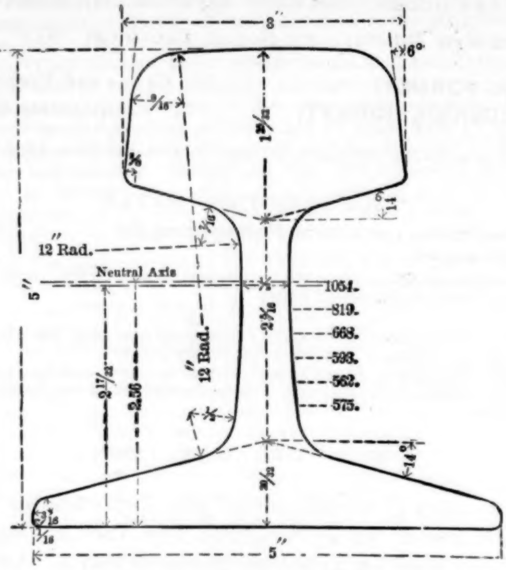


Fig. 1. Proposed 88 lbs.

thinking on this subject. For this reason every able discussion of the subject, like that contained in the paper of Mr. W. F. Mattes, which was read at the Scranton meeting of the Institute of Mining Engineers in February—which we regret we have not room for—must be regarded as a distinct advance towards agreement on some standard form for rails.

The shape of rail proposed by the author of the paper is that shown by fig. 1 which, it will be seen, differs from

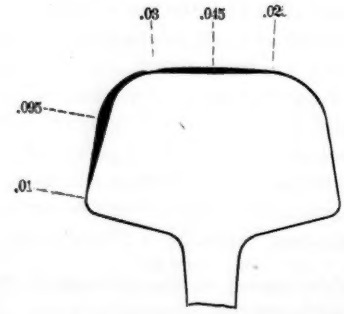


Fig. 2.

rail sections in ordinary use, chiefly in having a wider head in proportion to its weight, and a web which is thicker at the bottom than at the top. The reason given for this increase in the thickness of the web is that it increases the lateral strength and the vertical stiffness of the rail. But do we need more strength in our rails to resist the lateral thrust of the wheels? Do rails bend or break in the web? If they do, it is not generally known. About seventeen years ago the late Baron Von Weber made a series of experiments to determine how

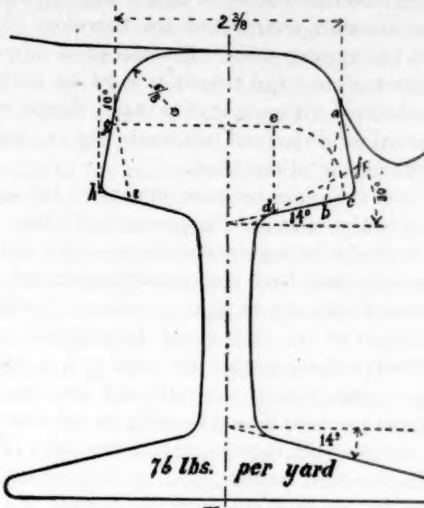


Fig 3

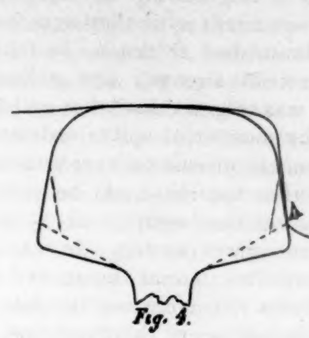


Fig. 4.

Fig 5.

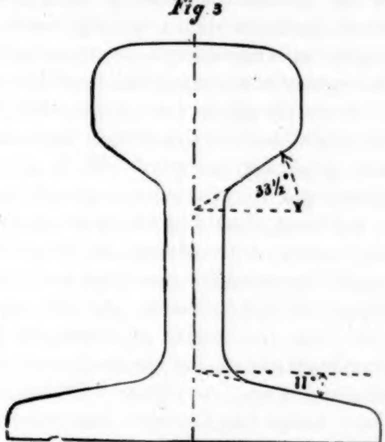


Fig 6.

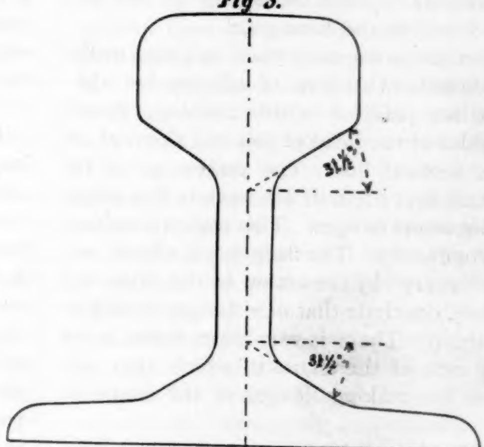


Fig 7.

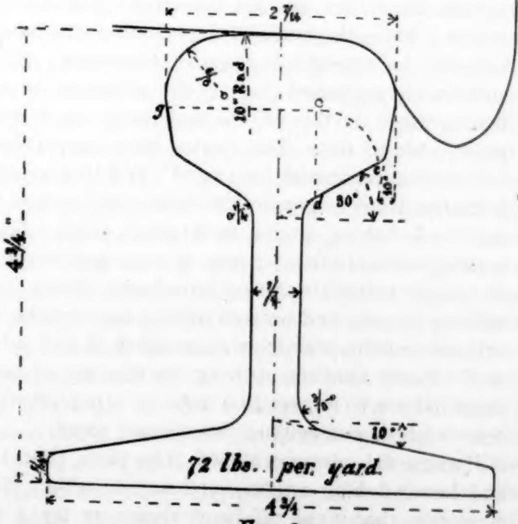


Fig. 8.

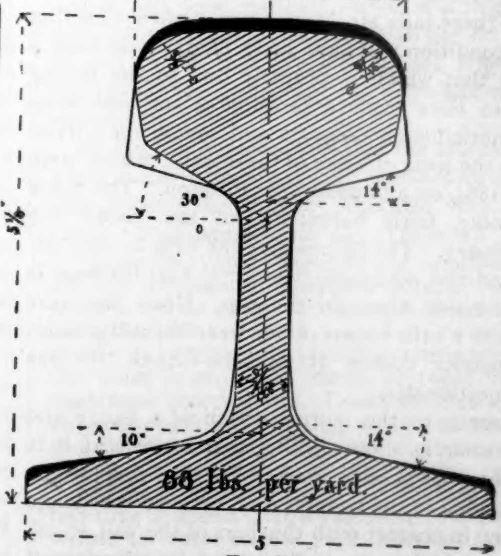


Fig. 9.

thick the webs of rails should be. A report of these experiments was published in *Engineering* in 1870. He planed down the webs of some rails until they were onlv ⅜ in. thick. With this diminished thickness, he found that they had ample vertical strength and stiffness, and their lateral strength was so great that, after spiking them down with double the number of spikes ordinarily used, they were all drawn out by means of a lever attached to the head of the rail, so that the rail could be turned sideways. His conclusion was that webs ⅜ or ½ inch thick were amply strong enough in practice. In fact, on a straight line, there is very little lateral thrust, and on curves the curvature of the rail increases the lateral strength enormously. It would seem, therefore, that to thicken up the lower part of the web adds to its strength when no addition is needed. In fact, to make the lateral strength of the web greater than the resistance of the spikes is useless.

It would seem, too, as if the vertical stiffness would be increased more if the metal which is added to the web were put into the base of the rail. In other words it does not seem that the metal required to thicken up the web is placed "where it will do the most good."

Fig. 3 is a section of the standard 76-lb. rail used on the Lehigh Valley Railroad. This form of rail may be taken as an example of late practice in this country. It will be seen that the sides of the head of this rail slope at an angle of 10° to a vertical line. The reason given for adopting this form is that the rails are worn to this shape by the action of the wheel flanges. This reason is neither satisfactory nor conclusive. The flanges of wheels are worn "square" or "sharp" by the action of the rails, but we do not, therefore, conclude that new flanges should be made square or sharp. There is very little, if any, more reason for making rails of the shape to which they are worn, than there is for making flanges of the shape to which they wear.

In fig. 3, a new wheel-tread is shown on the top of the rail with its flange in contact with the corner of the rail-head. It will be seen that the flange does not touch the side of the head at all. In fig. 4, a worn wheel-tread with a sharp flange is shown on top of the Lehigh Valley rail-head. In this case, it will be seen that the lower edge of the flange touches the side of the rail-head at *A*. Referring to these rails Mr. Mattes says, "wheel-tires that are in good condition will have little effect upon such a head beyond that which is properly due to the rolling load, but worn tires produce abrasion of the side slope that is very noticible on tangents and severe on curves. Fig. 2 shows the wear of some of these rails, which were laid in May, 1884, on a tangent near Pittston. The track there is double, fairly ballasted, and the traffic not particularly heavy. The figures give the wear in decimals of an inch, and the noticeable feature is that the wear is deeper on the side than on the top. Upon the next curve, of about 2°, the excess of side wear was still greater, and upon heavier curves at Mauch Chunk it was decidedly objectionable."

With reference to the mutual action of a flange and rail on each other, as shown in Fig. 3, is concerned, it is difficult to see what good is effected by that part of the rail-head included in the triangle *a b c*, because the flange does not come in contact with this part of the rail at all. On the other hand, it is generally agreed by experienced railroad men that if the lower edge of a flange impinges against the rail, as shown in fig. 4, that the flange is liable to mount the rail. In other words, the flanges which are of the right form *do not* touch the sides of rail-heads shaped like that shown in figs. 1 and 3, whereas flanges which are worn sharp, and are therefore dangerous, do touch the sloping sides. If, instead of sloping outward, the sides of the head sloped inward as indicated by the dotted line *a b*, Fig. 2, then a sharp flange would occupy the relation to the rail shown in fig. 5, and would not touch the side of the head.

It may therefore be inferred that so far as the mutual action of the rails and flanges on each other is concerned, that it would be better to slope the sides of the rail-heads the reverse way from that usually practiced, as indicated by dotted lines *a b* in figs. 3 and 4. If this were done the weight of the rail would be reduced, or the metal included in the triangles *a b c* and *g h i*, fig. 3, could be added to the top of the rail, and the section of metal available for wear would thereby be increased.

It may be said, though, that if the sides of the head are inclined inward, as indicated by the dotted lines *a b* and *g i* in fig. 3, that the bearing surface *d c* of the fish-plates will be diminished to an injurious degree. Before this objection is considered, let us give some examination to the shape of the under side, *d c* of the head.

The first fish-plates that were used were what are called "plain" bars, in distinction from angle-bars, which are now generally adopted. With plain bars it was considered essential that the angle of their top bearing under the head, should be the same as that of the lower bearing on top of the flange, so that the fish-plates or bars would be reversible, and thus avoid the risk of having them put on upside down. At the same time it was essential that the angles of these bearings should be sufficiently obtuse so that the bars could be kept tight by screwing them up. An obtuse "fishing-angle," on top of the lower flange has, however, the objection, that either the outer edges of the flange must be made very thin, or the middle of greater thickness than is required for strength, or perhaps both, as is the case in the Lehigh Valley rail.

There are two objections to thin edges on the flange: first, they are difficult to roll and liable to crack in rolling, and second, they have very little bearing surface against the spikes, and are therefore liable to cut into the spikes. More thickness in the center of the flange than is essential for strength is a waste of material. These considerations, as stated, led to the adoption of as small a fishing angle on top of the rail flange as it was found practicable to use. The angles have varied from about 10°, with a horizontal line, to 18°, and to prevent the fish-plates from being put on the rails upside down, the upper and lower fishing angles were made alike. That led to making them both as acute as was practicable. When the angle fish-plates were introduced, the necessity for making the top and bottom fishing angles alike no longer existed, but the practice was established and adhered to, and affords another striking illustration of how prone mankind are to adhere to a habit or a precedent after the reason for its continuance has passed away.

If angle fish-plates are used, it is plain that the upper and lower fishing angles need not be alike. It will be clear, too, that if the rail-head shown on fig. 3 was worn away so that its top would conform to the dotted line *g e c*, that the weak point of the rail-head would be on the

line $c\ d$ and that the fishing angle was made 30°, as indicated by the dotted line $d\ f$, that is if the metal is included within the triangle $d\ f\ c$ was entirely removed that the worn rail-head would still have substantially as much strength as it had before this change was made. In other words, the metal included in the triangle $d\ f\ c$ does not add to the strength of the rail-head, nor to the area of metal which is worn away, and consequently, if the fishing angle can be made 30°, this metal, and an equal amount on the opposite side of the rail, may be saved or added to the top where it will be useful in resisting wear.

The question then arises whether a fishing angle of 30° can be used without unduly straining the fish-bolts. Of course if they are unduly strained, they will break, but if they do not break with such an angle, it is evidence that the obtuse angle does no harm.

Fig. 6 represents a form of rail used on the Grand Trunk Railway prior to 1882, the upper fishing angle of which is 33½°. The Chief Engineer of that line has stated that there was no trouble from the breaking of bolts while that form of rail was used. Fig. 7 shows a rail used on the Great Southern & Western Railway of Ireland, the top and bottom fishing angles of which were both 31½°. We have testimony from both of these lines that there was no trouble from the breakage of bolts with fishing angles as great as those represented. On many other European, especially Continental roads, what would here be called very steep fishing angles are used. It therefore seems quite safe to use an angle under the head of 30°. There is also the advantage that with a steep angle, the fish-plates will hold the rails more truly in line. With such angles any inaccuracy of fit of the fish-plates on the rails, permits less lateral deviation of the rails than a smaller angle would.

In fig. 4 the external outline represents the head of the 76-lb. Lehigh Valley rail, and the dotted lines, the suggested changes therefrom. The areas between them show the metal which, if taken away, would not diminish the endurance of the Lehigh Valley rail section. It should be noted that, notwithstanding this reduction, the area which is available for wear, is nearly the same in the reduced section as it was in the original.

The aforegoing consideration, if put into practice, will then lead to a design of rail like that represented by fig. 8. This has a straight web 9-16 in. thick. A bottom flange 5-16 in. thick on the edges, which have flat, vertical surfaces, to give a liberal bearing for the spikes. The fishing angle on top of the flange is 10°, the angle under the head is 30°, with a horizontal line. The head is made $2\frac{1}{16}$ in. wide, measured over the curves of the top corners whose radii are ⅝ in. The Lehigh Valley rail is 3⅜ in. wide at the same point. The sides of the head of the proposed rail slope inward with an angle of 10° to a perpendicular. The bearing surface under the heads for the fish-plates is the same in both rails. Without going into refined calculations with reference to the relative stiffness of the two forms, the fact that metal is taken from near the neutral axis of the one section, where it contributes very little to the stiffness of the rail, and is distributed in the top of the head, and the edges of the flanges of the other section indicates that the one will not be inferior to the other in rigidity. This taken in connection with the fact that the proposed section will weigh only 72 lbs. per yard instead of 76 lbs., a difference of more than 5 per cent., is perhaps sufficient excuse for calling attention to the reasons which led to its design.

Returning now to the rail proposed by Mr. Mattes, it will be seen that he has not escaped from the habit of thinking that the top and bottom fishing angles should be the same. He has made them both 14°. If the bottom one was 10° he could increase the thickness of the edges of the flange for bearing against the spikes, which would distribute the metal nearer the bottom of the rail, which would then add to the stiffness without any increase in the area of this part of the rail section. If the increase in thickness and strength of the lower part of the web is needless, then the metal which has been added to that point could also be put into the flange, which would add still further to the stiffness. If the angle under the head should be increased to 30°, and the sides of the head were sloped inward, with an angle of 10°, instead of outward, the metal which could thus be removed from the lower part and sides of the head could be put on top, where it would add most to the wearing capacity and stiffness of the rail. Fig. 9 shows the modifications of Mr. Mattes' section as proposed above. The parts shaded with parallel lines represent the parts of the rails common to both sections, the black parts, what has been added to Mr. Mattes' section, and the unshaded portions, what has been taken away from it. The results of these changes would be that the superfluous material in the web, where it is not needed, would be put into the edges of the flange where it is of use. The rail would be increased in height about 2½ per cent. with a corresponding addition to its stiffness, and the metal in the top of the head, which is available for wear, would be increased from 15 to 20 per cent.

As stated in the beginning of this article, agreement on standard rail-sections will only be possible, when the reasons for adopting one form of section rather than another are thoroughly understood. To that end Mr. Mattes' paper is a very valuable contribution, and it is with the same object in view that it has been discussed here.

The Locomotive as a Hygrometer.

THE above title will probably lead some readers to inquire—an least mentally—what is a hygrometer? To save them the trouble of looking in the dictionary it may be well to say that Webster defines *Hygrometer* as "an instrument for measuring the degree of moisture in the atmosphere."

An English observer says that the manner in which the waste steam from a traveling locomotive conducts itself after leaving the chimney indicates very accurately the amount of moisture in the air. He says:

"Does the vapor linger in the atmosphere as if undecided whether to disappear or not? then saturation point is not far away. On the other haud, if it is snatched up with avidity, depend upon it it is a dry day with no chance of falling rain. Dwelling within a league of one of our main lines, I can testify of these variations from numerous observations. I have seen, on a hot summer's day, passenger trains rising an incline near our station, and therefore under full stroke of steam, without giving the slightest indication of their motive power, vomiting no smoke at the same time. At another time I have just had time to detect it ere it vanished. At others it has been visible for three or four yards, then for the whole length of the train, and so on, finally stretching, on damp and wet days, a long distance away. I have seen, in the height

of summer, steam hang about considerably, with large patches of blue sky overhead—a curious revelation to me at first. Indeed, this hygrometer is a very delicate informant.

"And some of the daily variations are not less remarkable. Working in a hayfield one day last summer, adjoining the railroad, I was determined not to let the opportunity slip by. Up to 1 o'clock each passing train had given a gloomy appearance, which seemed likely to continue, the sky being overcast, while the hay or grass refused to be made. But, somehow, soon after the sun burst forth, the sky grew clear, and the trains began speedily to prophesy, if it can be called so. Gradually the steam disappeared, the afternoon became exceedingly hot, and never did hay make faster. It was carried in that day; of course there was the same moisture in the air as before. The sun, in raising the temperature of the atmosphere, had made all the difference in giving it greater absorptive powers. A fortnight in the early hay season of last year was declared by this test to be phenomenally dry. Washerwomen and farmers please note when living near a railroad."

This observer's conclusions seem very reasonable, and they could probably be verified by the observations of others. Without doubt some of our readers have noticed something of the same kind; if they have, their observations may be of interest to others, and we would be pleased to hear from them.

NEW PUBLICATIONS.

LEVELING, AND ITS GENERAL APPLICATION; THOMAS HOLLOWAY. London and New York: E. & F. N. Spon, 1887. Octavo, xi + 147 pages. Price, $2.00.

THIS volume, written by a practical English surveyor, is of interest as exhibiting the methods of leveling field-work in England. The theory of the subject, including the methods of keeping notes and the adjustment of instruments, is set forth in a clear manner, and does not materially differ from the presentations given in our text-books on surveying. The practice, however, is different in many particulars. The leveling rod—called a staff—has no target, being universally of the "speaking" kind. The level is generally a "dumpy" with inverting telescope. The following extracts, selected almost at random, will give an idea of the methods recommended by the author:

"For general home use I prefer a 12-in. level, without either compass or short transverse bubble tube; but were I contemplating works of considerable magnitude, or emigration, I should prefer a 14-in. one, having a compass.

"To set up the instrument correctly: Remove the cap from the tripod. Erect the tripod by extending its legs to a convenient distance, and carefully examine it to see that it is quite free from shake, either from want of firm bedding and heading of the wood into the metal, or from looseness of any of the joints or screws. The examination being found in every way satisfactory, press the legs firmly either upon or into the ground, keeping the upper plate as nearly level as it can be kept by the eye, and mount the instrumeut by firmly screwing it on.

"Some surveyors compel the staff-holder to carry an iron shoe to plant the staff upon, but I never yet saw the advantage to be derived from its employment, although I am informed that it is good on loose, sandy soils.

"Some surveyors, when leveling up or down an incline, erect the instrument at some distance to the side of the line of operations, with the view of equalizing the lengths of the sites; this system is to be condemned, because it is more likely to increase error than to diminish it, and because it wastes time.

"Nothing can possibly contribute more to the assistance of an engineer, in the development of a new country, than contour lines; but as it is tedious and costly to define them, in respect of such differences of altitude as would render them of thorough practical utility, they are seldom employed."

Judging from this book, leveling in England seems to be a difficult operation, requiring much practice and great skill to succesfully execute. Even the bench-marks of the ordnance survey seem unreliable, for the author advises surveyers to ignore them "and proceed solely on the more reliable lines of self-dependence." Stadia leveling, now so common here, seems to be unknown in England, although the germs of the method are alluded to under the phrase "leveling aided by the application of the law of perspective," which, however, is merely an explanation of the way of determining horizontal distances by means of stadia lines in the telescope of the level. No statements are made as to the degree of precision attainable or desirable in leveling.

PETROLEUM, ITS PRODUCTION AND USE. By BOVERTON REDWOOD, F. I. C., F. C. S., New York, D. Van Nostrand.

THIS little book is abridged from the Cantor lectures before the Society of Arts, London, and forms another of Van Nostrand's Science Series. As its origin would indicate, it is written in a popular style, and begins with what may be called the geology of petroleum and its chemistry. The second chapter is devoted to a description of the methods of drilling oil wells, and of the appliances used for securing and increasing their product both in this country and in Russia. A description of the methods employed in the United States and elsewhere for transporting petroleum is also given in the second chapter. This is followed in the third with a description of "the processes adopted for the manufacture and distribution of the various commercial products, as well as to the methods employed for ascertaining the quality of these products and their suitability for the purposes to which they are to be applied." The fourth and last chapter is devoted to illumination, with descriptions of various kinds of lamps, wicks, etc., which have been devised and are used for lighting. Probably any one can get more information about the subjects which it discusses from this little book, in a few hours, than he could get from any other source within his reach. It is easy reading, and as interesting as a novel. It is without an index, which is its worst fault.

BOOKS RECEIVED.

SEVENTH ANNUAL REPORT OF THE RAILROAD COMMISSIONERS OF CALIFORNIA; Sacramento, Cal.: State Printing Office.

THE MEIGS ELEVATED RAILROAD.—By JOE. V. MEIGS. Boston: Charles H. Whiting. This pamphlet, or rather book, of 180 pages, contains an illustrated description of the Meigs plan for elevated railroads, with the arguments in favor of it.

REPORT OF THE SECRETARY OF THE NAVY. The report this year is of unusual interest, owing to the active work now in progress on the increase of the Navy.

TECHNICAL EDUCATION IN INDUSTRIAL PURSUITS, WITH SPECIAL REFERENCE TO RAILROAD SERVICE. This is a report made to the President of the Baltimore & Ohio Railroad Company by Dr. W. T. Barnard, Assistant to the President.

FOURTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF KANSAS: 1886. Topeka, Kan.: State Printer.

THE CRANK; Sibley College, Cornell University, Ithaca, N. Y. This is not, as its name might indicate, the organ of the car-coupler inventors, but a monthly magazine of very creditable quality, published by the students of Sibley College, and thus representing the students in Mechanical and Electrical Engineering in Cornell University. Its name is derived from the indispensable mechanical crank, not from the human variety.

CHALLEN'S ENGINEERS' LOG BOOK OF DAILY RUNS FOR THE YEAR; Howard Challen, 150 Nassau street, New York. This book contains a leaf for each week in the year; it is ruled and printed across two pages, giving the month; day of week; average pressure per gauge; hours run; revolutions; vacuum per gauge; piston speed (feet per minute); indicated horse power; initial pressure per indicator; terminal pressure; temperature of hot wells; temperature of heater; water per H. P.; fuel burned; ashes and waste; oil and waste used; defects reported; repairs made and remarks.

OBITUARY.

MR. THOMAS ADAMSON died recently at his residence in Cincinnati, O., aged 65 years. He was General Roadmaster of the Ohio & Mississippi Railway, and had been on that line over 20 years. Mr. Adamson took a prominent part in forming the Roadmasters' Association of America, and was Treasurer of the Association.

MR. JOHN E. PARKE, who died at Downingtown, Pa., April 10, aged 79 years, was one of the oldest railroad contractors in the country. He built part of the old road from Philadelphia to Columbia, and had several contracts on the Georgia Railroad, when the late J. Edgar Thomson was Chief Engineer. Mr. Parke remained in Georgia from 1833 to 1858, when he retired from business and went back to Pennsylvania to live.

MR. SAMUEL HOUSTON, who died of pneumonia at Piedmont, W. Va., April 10, had been for many years in the service of the Baltimore & Ohio Railroad. For some time past he had been Division Master Mechanic in charge of the Piedmont shops. He was 60 years of age.

MR. LEVI D. BRUYN died suddenly at his residence in Long Branch, N. J., April 10. He was born in Ulster County, N. Y., in 1835, and, after learning his profession as a civil engineer, was employed on several New York roads. About 1852, he went to New Jersey and was appointed Chief Engineer of the Raritan & Delaware Bay (afterward the New Jersey Southern) Railroad, and located most of that road. Subsequently he was Chief Engineer and afterward Superintendent of the New Jersey & New York road. For some time past he has been Resident Engineer of the New Jersey Southern and the New York & Long Branch roads.

MR. JAMES ROBERTSON THOMPSON, for 40 years chief owner of the Jersey City Steel Works, died at his resideece in New York, April 18, aged 65 years. He was born in Fulton County, N. Y., but spent most of his early life in Philadelphia. He established the steel works in Jersey City and has been at the head of the concern ever since.

HON. ALEXANDER MITCHELL died in New York, April 19, while on his way from Florida to his home in Milwaukee. He was born in Scotland in 1817 and came to this country in 1839, settling in Milwaukee, where he soon became known as a successful banker, and gradually accumulated a fortune. Of late years he has been best known as President of the Chicago, Milwaukee & St. Paul Company, having held that position since the present company was formed, 18 years ago. Mr. Mitchell served two terms in Congress from the Milwaukee District. He leaves a very large estate.

MR. JOHN LORD HAYES, who died in Cambridge, Mass., April 18, aged 75 years, was a lawyer by training and profession, but engaged in many other enterprises. In 1846, coöperating with others in Portsmouth, N. H., he organized the Katahdin Iron Works Company of Maine, for the manufacture of charcoal iron. He organized and was Secretary of the Mexican, Rio Grande & Pacific Railroad Company, and in 1854 obtained a charter from the Mexican Government which authorized the construction of a road across Mexico.

MR. HORATIO G. BROOKS died suddenly of apoplexy at his residence in Dunkirk, N. Y., April 20, aged 58 years. He was of New England orgin and learned the trade of a machinist in the Boston shops of the Boston & Maine Railroad; he was also employed on that road for some time as fireman and locomotive engineer. He went to the Erie in 1850, in charge of some locomotives from the Hinkley & Drury shops; he remained on the road till 1856, when he went to the Ohio & Mississippi, but four years later went back to the Erie as Master Mechanic of the Western Division. In 1865 he was appointed Superintendent of Motive Power of the whole road. In 1869, Mr. Brooks and his associates leased from the Erie Company its shops at Dunkirk, N. Y., and established the Brooks Locomotive Works, which have since become so well and widely known. The business of the works was gradually extended and built up until it was placed on a solid foundation, and the Brooks locomotive came to be known on railroads all over the country.

During the 17 years since the establishment of the works, Mr. Brooks has remained the active head of the concern, and the reputation which it attained was largely due to his mechanical experience and judgment. He was a very popular man and made friends wherever he went; he had also the friendship and good will of his associates and employés, whose welfare he cared for in many ways. Some years ago he established, in the Brooks Works, a school for the technical instruction of apprentices, which has done much good work.

Contributions.

THE GEODETIC WORK IN THE UNITED STATES.

III. THE UNITED STATES LAKE SURVEY.

BY PROF. J. HOWARD GORE.

CHRONOLOGICALLY, the next work of this character that reached completion was the United States Lake Survey. It was begun in 1841, finished in 1878, and when done it was well done.

The moving cause for this survey was the increasing lake traffic incident to the rapid settlement of the then Northwest, and the absolute necessity for that knowledge of the coast which alone could give to the lake sailors a feeling of security. The ultimate object, then, of this undertaking was to map the coasts of the Great Lakes, showing possible harbors, treacherous shoals and dangerous rocks. An objection may be here raised that this purpose would not bring this work under the head of Geodesy, on the ground that Geodesy pertains to the determination of the size and shape of the earth. But we shall soon see that the Lake Survey is being considered in its proper place if we can subscribe to the definition

given by General Cutts: "Geodesy, in practice, may be described as a system of the most exact land-measurements, extended, in the form of a triangulation, over a large area; controlled in its relation to the meridian by astronomical azimuths; computed by formulæ based on the dimensions of the spheroid; and placed in its true position on the surface of the earth by astronomical latitudes and differences of longitude from an established meridian."

This survey of more than 6,000 miles of coast needed to be checked by a strong chain of triangles, sufficiently near to connect with the secondary triangulation upon which the hydrography rested. This chain included 205 stations, it depended upon 12 bases, was oriented by azimuth observations at 11 stations and fixed in position by latitude determination at 16 points and longitude at 12. From beginning to end, it was directed by 9 different engineer officers, who had the assistance of 40 under officers and 127 civilians in the capacity of observers, computers, recorders, draftsmen and clerks. The published results are: 53 charts, with 110,897 distributed and a quarto volume of 925 pages, containing a report upon the primary triangulation, compiled by General Comstock, and published under the auspices of the Corps of Engineers, U. S. Army, in 1882. The entire cost for field and office work, together with instruments and publications was $3,037,509.

In the measurement of the base-lines in 1843 and 1844, a rope was stretched from two stakes 500 ft. apart, their tops being at the same elevation; upon this were placed, end to end, three well-seasoned wooden rods, each having in its under side a groove, so that it would easily rest upon the rope.

The Mackinac base was measured in 1844, in a manner that was a decided improvement upon the above. The apparatus in this case consisted of four iron bars, each 10 ft. long, resting one by one on a mahogany carriage, a little shorter than the bar, the whole being supported by two tripods. In measuring, the rods were placed level, and contact made by bringing the rear end of the bar so that it would touch a hair suspended from the forward end of the preceding bar, the hair being made vertical by an attached plumb-bob swinging in water—a method used in the Bessel apparatus prior to the employment of a sector to determine the inclination.

A Bache-Würdeman apparatus, 15 ft. in length, was purchased in 1857, and with it the seven bases of the following 20 years were measured. This apparatus, which was a combination of the principles of Colby and Borden with a few improvements, originated in the U. S. Coast Survey, and will be described in an ensuing article.

Without reflecting upon his predecessors, it must be acknowledged that when Colonel Comstock was placed in charge, many improvements in both instruments and methods were introduced. In the Minnesota Point base a middle point was selected, which, with the two ends and an auxiliary station suitably situated, formed three triangles, making it possible to compute the length of each segment from the measured whole. The discrepancies thus found between the values for the two parts were — 0.506 in. and + 0.507 in., while the probable error in the entire line was 0.45 in. in a distance of 3.8 miles. As computed from Keweenaw base, about 240 miles distant, the length was 2.55 in. shorter than was found by measurement.

The Fond du Lac base was also computed from the Keweenaw base through a chain of 320 miles, giving a length only 1.16 in. shorter than the measured value. The discrepancy in this instance was one-fifth the error that might have been expected from the probable errors in the determination of the angles of the intervening triangles.

In the measurement of the Keweenaw base in 1873, the apparatus was protected from the action of the sun by a movable awning. In obtaining the probable error, 0.419 in., there were considered the following sources of error: Ascertaining the length of the tube; determining the inclination; reference to and from the ground; change of the length of the tube and reduction to sea-level arising from the uncertainty in the elevation of the base.

The Sandy Creek base was measured twice in 1874; the difference in the two results was only 0.545 in., and the probable error was 0.21 in. In the preceding measurements a short segment was measured two or more times as a test, but the behavior of the apparatus was such as to warrant the acceptance of a single determination.

There was an intermediate point fixed in the Buffalo base and an additional station taken so as to make it possible to compute the length of each segment. The computed values differed from the measured by — 1.04 in. and + 1.06 in., while the length, computed from Sandy Creek base through a chain of triangles whose axis was 210 miles, differed from that found by measurement by 1.44 in., which was only one-third of what might have been expected from the errors in the connecting triangulation.

The Repsold apparatus arrived in 1876, and with it the three bases of the three following years were measured. In this apparatus there are two bars, one steel and one zinc, fastened together at their middle, but free to expand throughout the rest of their lengths. Their unequal expansion is observed upon scales at both ends, making a metallic thermometer on the Borda principle. The two bars are placed within a tube cylinder, which supports them rigidly and protects them from sudden changes of temperature; being further protected during measurement by a covering of thick felt, with a movable awning of sail cloth over the entire apparatus and observers. The tube is provided with a sector to indicate inclination, and a telescope for aligning. In measuring, two tripods carry the tube, these rest upon foot pins, and their heads have three motions as usual. The microscopes have stands similar to the tube tripods; but instead of simply serving the purpose of a marker, the microscopes have a micrometer, in which the fixed wire is adjusted directly over the zero mark on the steel bar, while the movable wire is made to bisect the nearest graduation on the zinc bar, giving a scale reading. From a large series of scale readings at different authenticated temperatures, the value of the scale in terms of degrees of temperature is found, so that, knowing the coëfficient of expansion, temperature, and temperature of the standard length, the exact distance between the zero marks on the steel bar can be known for each tube, and the sum of the projections of such lengths will give the length of the base. In using this apparatus, every precaution then thought of was observed, even to having platforms upon which the observers stood; the points of support so placed that the weight of the observer would be equally distributed about the microscope stand, making it impossible to have all the weight

on one side, and in this way cause a change in the microscope pointing as the observers changed position.

The Chicago base was the first upon which this apparatus was employed. It was divided into 8 segments, and in the second measurement, the discrepancy of the two were noted; in no instance did this exceed three-millionths of the segment. The ends of the base were marked by small agate hemispheres set in brass cylinders which were leaded into the tops of granite blocks set in brick work, the agate being three feet below the surface of the ground. The probable error in measuring was 1 : 1,052,200; as computed from the Fond du Lac base, the discrepancy was 1 : 53,616.

The Sandusky base had two angles in it, thus breaking it into three nearly equal parts. A fifth point was selected so as to give well-shaped triangles, through which each segment was computed from the ascertained distance between the two ends. The computations of the segments gave results differing from the measured values by — 0.048, + 0.015 and + 0.033 ft., while the length, as computed from the Buffalo base, 250 miles distant, gave a difference of 0.127 ft.

The Olney base gave 0.0214 ft. as the probable error, and the measured length differed by 0.199 ft. from the value found by computation from the Chicago base, 200 miles distant.

As we have seen, four different kinds of apparatus have been used during the progress of this survey. The first two were too unreliable to deserve special attention. The other two were constructed upon principles that had strong supporters, each more or less anxious to see his preference take precedence. The salient points of difference were the substitution of the the single tube in Repsold with the metallic thermometer and microscopes for the two tubes of the Bache-Würdeman with the compensating lever and contact level. In the matter of time, the former requires the services of 17 men, and measures an average of 73 tubes a day; the latter needs 25 men and averages 78 lengths per day, working under the same auspices. The average probable error found in using the Repsold apparatus was 0.186 in., the Bache-Würdeman gave 0.365 in.; a value relatively twice as great, though differing absolutely by only 0.18 in.

The standards used prior to 1876 were two yards compared with the Ordnance Survey yard by Col. Clarke; upon his comparisons depend the 15 ft. brass bar which was compared directly with the base apparatus of that length, and the measurements were referred to this brass bar at the temperature of melting ice. When the Repsold apparatus arrived, it was accompanied, by a meter, to whose length all subsequent measures were reduced. This was compared with the standard meter in Berlin by Foerster, and afterwards in Paris by Sainte Claire Deville, who gave as the length of the meter, 39.36985 in. at 57° 92 Fah. with .00000585 as the coëfficient of expansion for 1° Fah.

The experience regarding theodolites resembled here that of other parties—beginning with 20 and 24-in. circles, but finding the size a disadvantage in the matter of transportation and nothing in accuracy gained, the large instruments were gradually abandoned and the size reduced to 12 and 14-in. circles having two or three microscopes, and reading to single seconds or to two seconds. Likewise the principle of repetition held sway for a long time, and was not fully discarded until 1872.

Before computing distances and geographical coördinates, a large net of triangles was so adjusted by least squares as to fulfil the usual geometric conditions that the sum of the three angles of a triangle, after being transformed from a spherical to a plane triangle, should be 180°, and that the angles or directions should be the same in every possible combination; and, in addition, that the length of each side should be the same when computed by every available route, or from any accessible base. When the number of conditions permitted it, the entire chain between and including two bases was adjusted as a single figure; this, in one instance, necessitated the solution of 98 equations.

Prior to 1864, a single pole supported the theodolite when it was necessary to elevate it, surrounded by a platform built upon a separate structure, for the observer. After this time it was found better to have an inner tripod for the instrument, with a surrounding scaffold. In one instance, at Pine Hill, a tree was cut off 104 ft. from the ground for the theodolite support; this was 4 ft. higher than the stump around which the Great Caspar signal was constructed. The highest signal built was 150 ft. high. On short lines, a target, painted white and black, was attached to the center pole, but, when the distance was too great to allow this to be visible, a helioscope was used—in some cases a modification of Gauss's that diminished the size of the pencil of light. The longest line was 101 miles. In all cases the coördinates of the center of the target, referred to the geodetic point, were determined with the utmost precision by plumbing down with a small theodolite. This geodetic point was marked in the same manner as were the termini of the bases, and so described in the record, that each could be found.

When the method of directions was employed, only five were taken in a set, so that each set would not require more than 10 or 15 minutes. If there were more than this number of stations visible, a new initial point would be selected and the remaining directions observed. Sixteen combined results were usually required to be obtained for each angle, but sometimes 24 would be made. Great care was taken to eliminate instrumental errors: eccentricity, by reading all the microscopes; periodic, or accidental errors of graduation, by reading each angle an equal number of times on every 30° or less around the limb; collimation, by reversal. When the probable error of a direction exceeded 0″.3, it was regarded with suspicion and given as little importance as possible in the subsequent computations.

The observations for longitude, latitude and azimuth were made in accordance with the methods that were considered as the most approved. Though, in a few cases, when telegraphic facilities were not available, longitudes were determined by noting the difference in local times between the time of making a flash of powder at one station and the time of observing it at another. The difference between the observed and computed latitude reached 11″.6 as a maximum, and 14″.3 was the maximum difference in longitude. This might naturally be ascribed to a local deflection of the plumb-line, as so many of the stations were on the shore of a deep lake where the difference in the densities of the water on the one side, and the hills on the other would produce a noticeable effect.

Though this work, as was said at first, was prosecuted purely in the interests of topography and hydrography, yet the accuracy with which it was accomplished is such

that the results can be applied to that more extended object of geodesy—the determination of the earth's elements.

The entire triangulation embraced an arc of $11^\circ\ 47'\ 40''$, which gave for a degree along the 42d parallel (271,905.3—69.5 *d e*) ft., in which *d* represents the difference between Clarke's value of *e* and whatever value may, in the future, be adopted. It was found that a degree of a meridian in the mean latitude $43^\circ\ 41'\ 10''$ is 364,439.3 ft. The former is 66 ft. more than Clarke's spheroid gives, while the latter is 76 ft. less.

The survey, from beginning to end, passed through many stages in its development; not being wedded to any particular method, each was discarded as soon as a better one presented itself, until the very best known had become incorporated. For this reason, I know of no work which better illustrates the growth of geodesy during the same period than does this survey, nor a report that contains so much of interest and information as Comstock's Report on the Primary Triangulation.

RIBBED BOILER TUBES.

[By M. Chomienne, Engineer of the forges of L. Arbel, Rive-de-Gier, France.]

IN tubular boilers, even the most nearly perfect, such as the locomotive boiler, there is still a considerable loss of heat in consequence of the insufficient absorption of caloric.

This loss of heat takes place notwithstanding the great increase of the heating surface. This fact is explained by the enormous quantity of gas which passes through the tubes without coming in contact with their walls.

The radiating power of gas being almost nothing, it follows that the transmission of heat can only be made by contact. The solution of the problem then is in the increase of the surface of contact.

In his Treatise on Heat, Petiet says:

"The transmission of heat can be increased by another proceeding, which has not been put in practice, but which, in certain cases, might be very efficacious. We have seen that, for the transmission of heat through a plate, it is necessary to distinguish the absorption by one of the surfaces, the emission by the other and the conduction through the thickness of the metal; under ordinary circumstances the quantity of heat which the metal is able to transmit is much greater than that which it has to transmit. It follows from this that, if, instead of using plates made in different ways, we should use plates traversed by ribs or bars projecting a certain distance into the two fluids, gaseous and liquid, one of which is to impart heat to the other, in thus increasing the extent of surface in contact with the two fluids we would largely increase the effect produced."

M. Ledieu says, in his work on marine boilers:

"Tubes of small diameter, like those used in boilers, have the advantage of presenting, with the same total cross area, a much greater heating surface, but they do not absorb as much heat as their total extent and the high conducting power of the metal would make us suppose.

"The gases which enter the tubes run in parallel lines to the outlet; those parts of the gas which are in contact with the surface of the tube are well cooled, but, as they form always the exterior part of the gaseous stream, they constitute a surface or wrapper with very little conducting power for the heat of the gas which is in the central part of the tube, and finally the total mass reaches the chimney without parting with a sufficient quantity of its heat."

This explanation makes it clear why, in a locomotive, tubes of 4 meters (157½ in.) in length produce almost as much steam, other circumstances being equal, as tubes of 6 meters (236¼ in.). This shows very clearly the necessity of obtaining the heat which exists in the center of the tube, and it is this which has led M. J. Serve, of Givors (Rhone), to seek for an increase in the surfaces of contact.

He has reached this end by substituting for the ordinary smooth tube, a tube carrying inside longitudinal ribs, and to this he has given the name of ribbed or finned tube (*tube à ailerons*). He has thus been able to utilize a much greater proportion of the heat of the gases, as we shall show later.

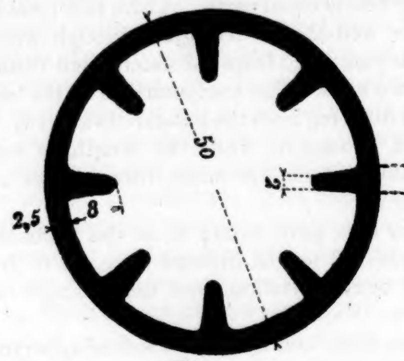


Fig. 1.

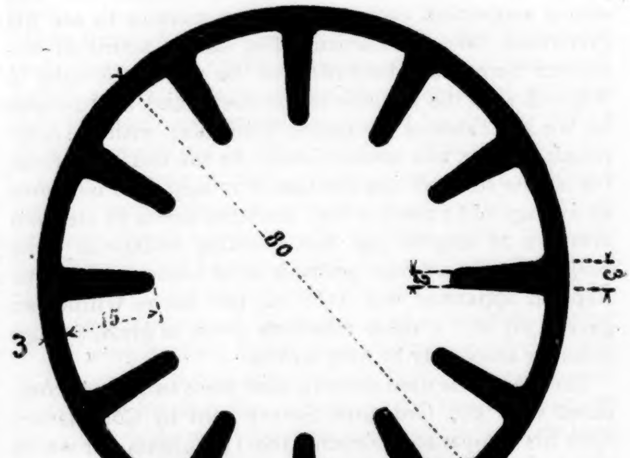


Fig. 2.

The conducting power of the metal transmits immediately to the surface of the tube the heat from the concentric layers in the same tube. It follows that the power of vaporization is increased in very large proportion. The quantity of heat absorbed (we speak only of that which would otherwise be lost) is proportional to the number of ribs and their projection into the tube. The number of ribs arranged regularly around the tube may be 8 in tubes of 50 millimeters (2 in.) diameter or less, and 10 in tubes of greater diameter; their projection into the interior of the tube from 8 to 15 millimeters ($\frac{3}{16}$ to $\frac{9}{16}$ in.) and their thickness from 2 to 3 millimeters ($\frac{1}{12}$ to ⅛ in.). The accompanying cuts, figs. 1 and 2, show two specimen tubes, one of about 2 in. and one of 3⅛ in. diam-

eter. The dimensions given on the cuts are in millimeters.

Under these conditions the manufacture of the tubes will present no difficulty, and the price will be only slightly greater than that of the ordinary smooth tubes (La Société Industrielle et Commerciale des Metaux has already delivered a number to the inventor, and is negotiating with him for the exclusive right to manufacture them).

We can also add that these tubes can be cleaned out as easily as the ordinary tubes by means of the tube-brush.

It will also be possible in case of wear in the end near the fire-box to piece out these tubes with an ordinary tube of the same diameter, without sensibly diminishing the useful effect.

Certain experiments were made by M. Bounardel in the tubular boilers of his steamboat, *Le Bourdon*, plying on the Rhone between Lyons and St. Louis. The tubes used in this case were of 100 millimeters ($3\frac{15}{16}$ in.) diameter outside and 3.5 millimeters ($\frac{1}{8}$ in.) in thickness. The tubes have 8 ribs having 13 millimeters projection, 3.5 thick at the base and 2.5 at the point. (Some of the details of this experiment are omitted as not necessary to a comprehension of the results.)

The boiler was first used with new tubes of the ordinary smooth kind, of copper. Put in service, it vaporized 6.930 kilogrammes of water to the kilogramme of fuel used. The smooth tubes were then replaced by ribbed tubes of the new system and the boiler vaporized 9.338 kilogrammes of water to the kilogramme of fuel—the fuel used being of the same kind and taken from the same lot as in the first trial.

In this case the saving was 35 per cent., but it may be observed that in this boiler the heating surface of the tubes was only $6\frac{1}{2}$ times that of the fire-box, while in locomotives it is 8, 10 or even 12 times as great. From the time the boiler was started up it was easy to see that the economy would be considerable. In fact, in working with the smooth tubes, the sheet-iron base of the smoke-stack burned paper held against it, while with ribbed tubes the paper was uninjured.

In the second trial made in the boilers of the steamboat *Le Bourdon*, one voyage was made going and returning with each of the systems of tubes.

With the smooth tubes the gases of combustion escaped into the smoke-stack at a mean temperature of 360° Centigrade (680° Fahrenheit) measured by a Shaeffer & Budemberg pyrometer, and sometimes reached a temperature of 450° Cent. (842° Fahr.). A ball of lead introduced in an iron cage into the smoke-box melted quickly.

With the ribbed tubes the mean temperature of the escaping gases was 240° Cent. (464° Fahr.) and the lead ball did not begin to melt, which shows that the temperature never rose to the point at which lead melts (330° Cent.).

The fuel consumed in the voyage with the ordinary tubes was 45,000 kilogrammes; with the ribbed tubes, 34,150; showing a saving of 10,850 kilogrammes, or 24 per cent.

It must be remembered that, in a steamboat voyage, as with a locomotive, the factors making up the resistance are numerous and are not often the same. The surest means of realizing the economy secured by the ribbed tubes is to take the temperature of the gases at their entry into the smoke-box; in this way no error is possible.

The tubes used in boilers by the Compagnie Générale de Navigation were of so large a diameter (100 millimeters or nearly 4 in.) that they could hardly be available for the complete utilization by the ribs of the heat produced in the fire-box. With so large a diameter it was difficult to give the ribs sufficient projection to enable them to draw out the heat from the center of the tube. There was in the use of these large tubes what may be called an injurious or useless space, the ribs having too little projection.

The tubes of marine boilers, on the other hand, vary from 70 to 85 millimeters ($2\frac{3}{4}$ to $3\frac{1}{3}$ in.) diameter, and locomotive tubes have not more than 50 millimeters (2 in.). In these the ribs can easily be made with sufficient projection to reduce the useless space to the smallest possible limits, and with these a closer approach can be made to a theoretically perfect utilization of the heat.

Experiments made by M. Serve with apparatus made for the purpose and so arranged that heat could be transmitted only through the ribs, the wall of the tube between the ribs being carefully isolated, still showed very favorable results in favor of the ribbed tube.

The experiments made by Graham and Petiet show that the efficacy of the heating surface of tubes decreases very rapidly as they approach the smoke-box, and show, consequently, the uselessness of long tubes.

Only a very great increase of heating surface will make it possible to absorb the heat of gases at a comparatively low temperature. The following calculations show that this increase can only be obtained by ribbed tubes, without any other change in boilers. In the table below the heating surface is calculated on the exterior diameter of the tubes, while the section for the passage of the gases is calculated on the interior diameter. The thickness of the tubes is taken at 2 millimeters in each case and their length at 4 meters; the interval between each tube, whatever the diameter, remains the same, being taken at 20 millimeters.

PLAIN TUBES.

Diameter. Exterior.	Diameter. Interior.	No. of tubes.	Total surface of tubes.	Interior section of tubes.
Millimeters.	Millimeters.		Sq. meters.	Square meters.
50	46	180	113	0.2989
40	36	245	123	0.2491
30	26	353	133	0.1870
RIBBED TUBES.				
50	46	180	228	0.2629

These comparisons show that, with smooth tubes, if we replace 180 tubes of 50 millimeters diameter by 353 of 30 diameter (occupying the same surface as the preceding) we only gain 20 square meters of heating surface, while we lose on the other hand 0.11 square meter of section out of 0.30, or more than a third.

By changing plain tubes for ribbed tubes we double the heating surface and lose only 0.025 square meter of section, or about one-fifteenth.

These figures require no comment and show the great superiority of the ribbed tubes.

In conclusion, it is claimed that, with the ribbed tubes, there will be a more complete utilization of the heat and more rapid steaming. In locomotives, consequently, larger blast nozzles can be used and a freer exhaust allowed,

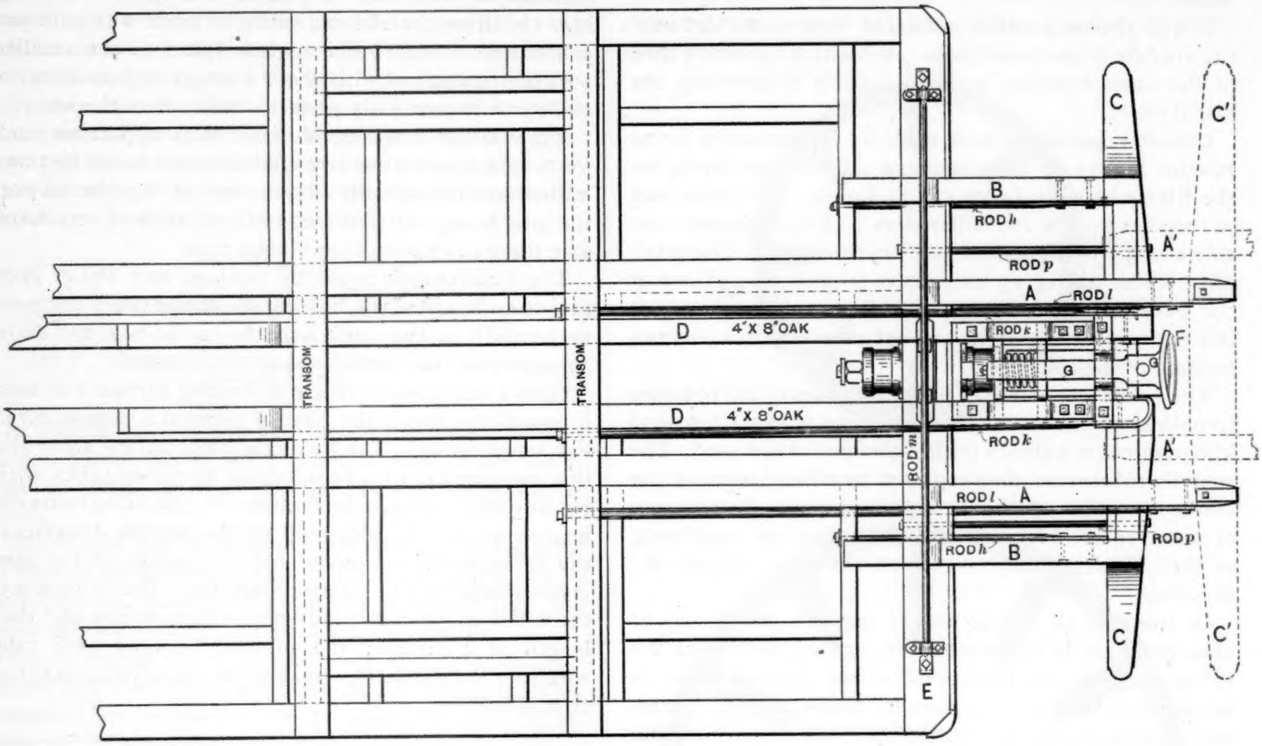
reducing the back-pressure. As it will not be necessary to drive the fire and hasten the disengagement of steam, there will be less trouble from wet steam. The gases of combustion being drawn through the tubes at lower speed, there will be less drawing of cinders into the tubes, and less cleaning will be required. The gases will reach the smoke-box at a lower temperature.

The ribs will increase the strength of the tubes, and all support in the center can be dispensed with; this support or bracing is a frequent cause of wear. As the tubes can be made shorter, the effects of expansion and compression will be less felt.

The use of these tubes in marine boilers will diminish the quantity of coal which it is necessary to carry for a voyage, thus increasing the cargo space.

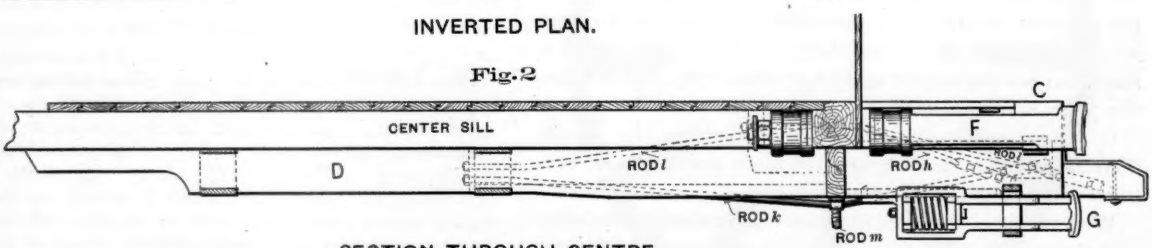
In short, the economy resulting from the use of these tubes will be considerable, in all the applications which may be made of them.

Fig. 1



INVERTED PLAN.

Fig. 2



SECTION THROUGH CENTRE.

THE BLACKSTONE PLATFORM AND COUPLER FOR PASSENGER-CARS.

BLACKSTONE'S CAR-PLATFORM AND COUPLING.

IN an article in the February number of the JOURNAL, on "Heating Cars," attention was called to the fact that in collision the floors of one car usually mounts above that of the other, and the upper car then crushes through the side of the lower one. As the side has very little strength to resist the momentum of the train under these conditions, a slight concussion will cause a serious accident. If the floor timbers of the cars could be kept in line, that is, if the one car could be prevented from raising up above the other, then the whole strength of the longitudinal sills would resist the force of the collision. Some rough diagrams were published with the article referred to, showing how the "horn timbers," which are used in connection with the Blackstone platform, keep the floors of adjoining cars in line with each other. In order to show the construction of this platform more perfectly, the engravings herewith have been made from a drawing for which we are indebted to Mr. Wm. Wilson, Superintendent of Machinery of the Chicago & Alton Railroad.

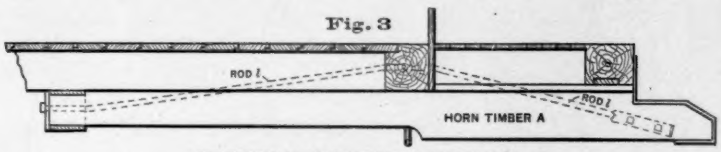
The engravings will require but little explanation. As will be seen, their cars are equipped with two draw-bars to couple with others of a different height from those used on the Chicago & Alton Railroad. The feature, though, to which especial attention was called in the February number of the JOURNAL, was the "horn timbers" *A A*, which are bolted below the sills of the car and extend back to the transom or bolster. These timbers are strengthened with truss-rods *l l*, which can be made of any required strength. The relative position of the horn

timbers $A' A'$ of the adjoining car is shown by dotted lines in fig. 1.

These horn timbers could be used with almost any kind of self-coupler.

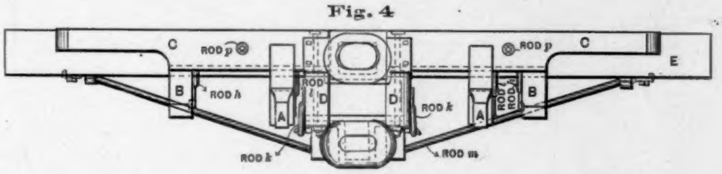
A common impression prevails that Miller platforms are an effectual preventative of telescoping. Many accidents have shown that such is not the case. The Miller platform has very little, if any more, capacity to resist concussion if the cars are not kept in line with each other than the old-fashioned car frames had. The only thing which prevents cars with Miller platforms from mounting on top of each other in collisions is the draw-hook, and this is usually so insecurely fastened that it has comparatively little strength. The "horn timbers" which Mr. Blackstone has devised can be made with any amount of strength, and, it is believed, would do as much to prevent telescoping as the Miller platform has or will. Probably a good many more lives will be sacrificed before the value of Mr. Blackstone's device will be generally recognized. It would not require very great prescience to prophesy that one or more horrible accidents will occur in the not very remote future, in which a good many lives will be sacrificed and which will cause inexpressible suffering; all of which might be prevented by the adoption of the simple device illustrated in the engravings, and which any company is now at liberty to use.

Fig. 3



SECTIONAL VIEW SHOWING HORN TIMBER.

Fig. 4



END ELEVATION.

A New System of Heating Railway Carriages.

(From *Engineering*.)

THE efficient and economic heating of railway carriages in northern climates has long been a vexed question, and many inventors have endeavored to solve it; but the success which has hitherto attended their efforts has in most instances, been of a qualified character. It is satisfactory to know, however, that there is now a prospect of the object aimed at being attained in a thoroughly successful manner. In this case the inventor is Mr. William Foulis, M. Inst. C. E., the Manager-in-Chief to the Glasgow Corporation as Commissioners. That gentleman has devoted much attention during the past year or two to the practical utilization of coal gas as a heating agent, and more especially in devising various ingenious forms of water-heaters of almost instantaneous action. His newest invention involves a further application of the same principles as are turned to account in his water heaters for domestic and other purposes.

In applying his skill to the heating of railway carriages Mr. Foulis takes advantage of the fact that large numbers of them are already fitted with various forms of gas lamps for supplying light; and his aim has been to bring the heat that is developed in the roof of the carriage while the gas is alight down to the floor of the compartment, so as thereby to keep the feet of the passengers comfortably warm, and the whole atmosphere of the compartment at an agreeable temperature. He uses water as the medium for transmitting the heat of the gas flame from the one place to the other. A boiler is placed in the roof of the carriage over the flame of the gas lamp. It is of very simple construction, and the principle on which the heater works is that the heat from the flame comes into contact with the boiler at the point where the water is hottest and leaves it where it is coldest. From this boiler there descend two pipes about ¼ in. in diameter, which are connected to two annular tubes placed underneath the carriage seat. The course which the two pipes take is down through the wooden partition separating the contiguous compartments. Hot water circulates through these pipes and annular tubes, and it returns to the boiler after having given off its heat. The reversal of the current is accomplished by allowing the hot water from the boiler to ascend in a tube a few inches in length, on the top of which there is a small valve. Having passed up this tube, and being unable to return to the boiler, the hot water is made to circulate downward through the pipes. The annular tubes already referred to are about 3½ in. in diameter, and about 8 in. long. They are laid at an angle under the seat, the upper end being raised as far as practicable. The pipe which conveys the hot water is connected to the top of these tubes, and that which carries the return current is connected with the bottom of the same.

Owing to the fact that the tube is placed at an angle and that it is heated, an induced current of air is made to pass through it; and as the air enters the tube at the cold end and leaves it at the hot end, it absorbs the maximum amount of heat from the water. The air flows from these tubes or heaters in a constant stream at a temperature of from 80° to 90°. It has been found that the ordinary size of gas flame is quite sufficient to do the heating of a compartment, though the consumption of gas is less than one cubic foot per hour, and even during the coldest days of winter.

We may mention that the carriage used is a composite one of four compartments, the property of the Glasgow & Southwestern Railway Company. The internal construction of the carriage was entirely rearranged under the superintendence of Mr. Foulis. During the past two months or so numerous experimental runs have been made with this carriage as part of a regular passenger train, several of them being to and from Carlisle. On one or two occasions the patentee has been accompanied by Mr. Smillie, Locomotive Engineer, and other leading officials of the Glasgow & Southwestern Railway Company; and in all cases they have expressed themselves as highly satisfied with the results achieved by Mr. Foulis. The present writer had the pleasure of joining in one of the runs from Kilmarnock to Carlisle and back when the weather was wintry in the extreme, all the hills for many miles being covered with snow. Inside the carriage the temperature was most agreeable, and in marked contrast to the outside. A thermometer hung in the compartment, in which there were only three persons, never fell below 52°, and the extent of the range was only 2°. On other occasions the temperature ranged from 56° to 60°.

Of course, in carriages heated on the Foulis system the gas must be constantly burning—by day as well as by night; but if heating for the comfort of the passengers is to be done it matters not though the heat is obtained from a luminous flame, providing that it is comparatively inexpensive. In this case it is remarkably economical, while as soon as darkness sets in the gas flame does double duty, providing both heat and light. So far as can be seen at present, it must be unhesitatingly declared that Mr. Foulis has made a most important invention; and much credit is due to the directors of the Glasgow & Southwestern Railway Company for giving him facilities to enable him to bring it to its present perfect stage.

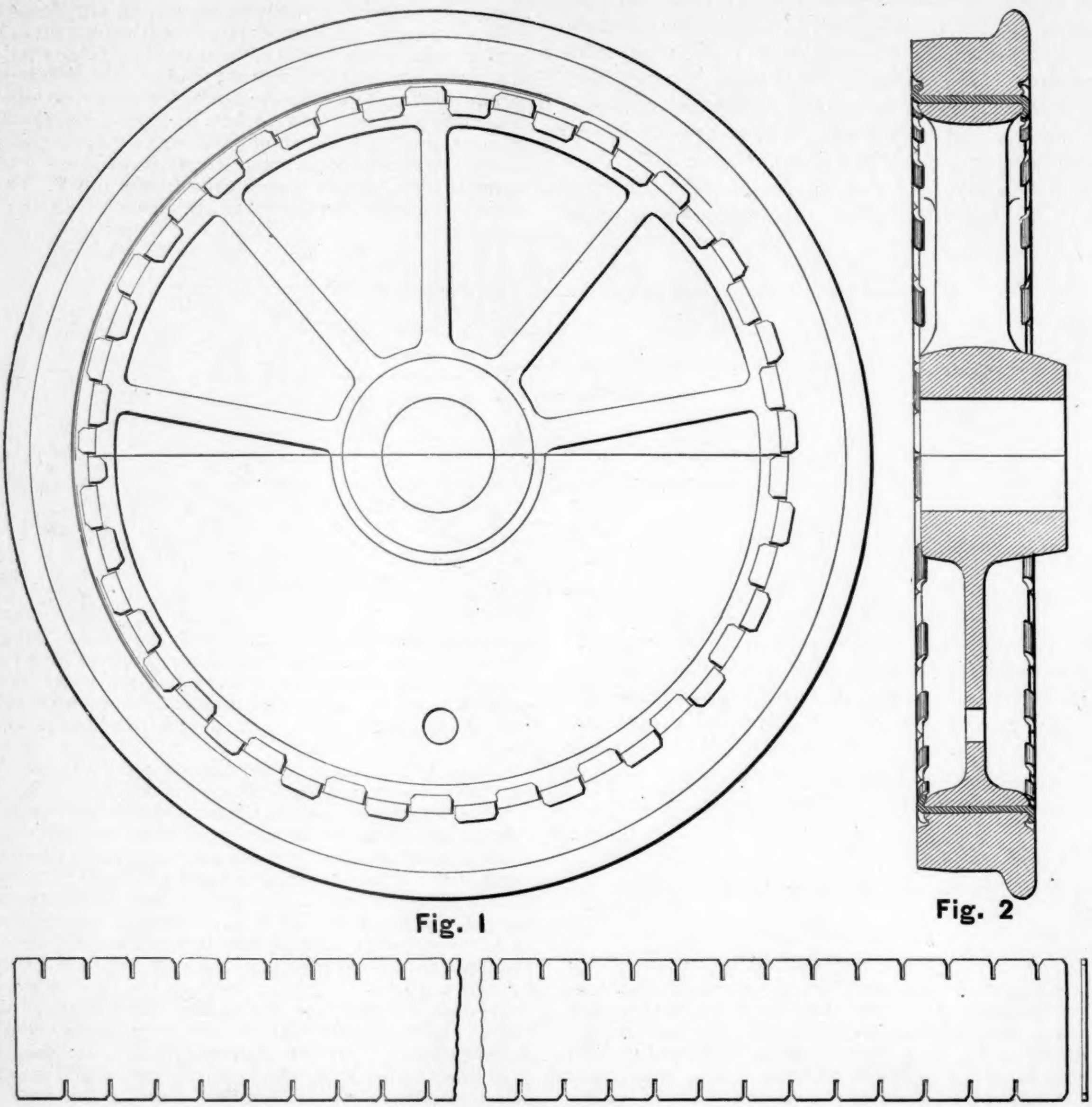


Fig. 1 Fig. 2

Fig. 3

CLOUD'S METHOD OF FASTENING STEEL TIRES.

CLOUD'S METHOD OF FASTENING STEEL TIRES.

THE engravings represent a method for fastening steel tires on car-wheels, which has recently been patented by Mr. John W. Cloud, Superintendent of Machinery of the New York, Lake Erie & Western Railroad.

It consists of a plate, fig. 3, with notched or serrated edges, which is inserted between the rim of the wheel-center and tire before the tire is shrunk on, and is firmly clamped between them by the contraction of the tire. This plate is made broader than the contact surfaces of the tire and wheel-center, so that the projections on the edges can be bent over, as shown in figs. 1 and 2. The metal strip then performs the double function of preventing the tire from slipping laterally on the wheel-center, and of preventing it from moving radially away from it when fractured.

This plan provides a very simple and cheap method of securing tires to the wheels. Mr. Cloud's address is Buffalo, N. Y.

Painting Signals in France.

The *Revue Générale des Chemins de Fer* of recent date, says that as the result of numerous trials, begun four years ago in its shops at Ermont, the Northern Railroad Company has just issued rules intended to secure fixed colors and durability in the painting of its signals:

"The different colors used are red, white, black, green, yellow and violet, which should be mixed in the liquid composed of oil, essence, dryer and varnish in fixed proportions, by weight (which it is not necessary to repeat here, especially as the formulæ for the liquid and the colors are not given).

"To paint with one coat, and to cover with a coat of varnish the different signals, the following materials are employed:

"1. Distant Signals: 110 grammes red paint (mixed), 65 grammes white paint, 30 grammes black paint and 50 grammes varnish.

"2. Stop Signal: 60 grammes red paint, 135 grammes white paint, 35 grammes black paint and 55 grammes varnish.

"3. Round Cautionary Signals: 65 grammes green paint, 65 grammes white paint, 30 grammes black paint and 35 grammes varnish.

"4. Junction Signal: 40 grammes green paint, 145 grammes white paint and 55 grammes varnish.

"5. Direction Signal: 50 grammes violet paint, 220 grammes white paint, 15 grammes black paint and 75 grammes varnish.

"6. Switch Signal: 25 grammes green paint and 10 grammes varnish.

"7. Large Semaphore Arm: 75 grammes red paint, 65 grammes white paint and 30 grammes varnish.

"8 Small Semaphore Arm: 35 grammes yellow paint and 20 grammes varnish."

TERRACE PARK STATION, BUFFALO, N. Y.

THE two full-page engravings, with this number of The JOURNAL, represent the front and rear elevations and plan of a new station, which is now in progress for the New York Central & Hudson River Railroad in Buffalo, N. Y. The main building is 27 × 139 ft., with an entrance vestibule 17 × 17 ft. The waiting room is 19 × 65 ft. The platform sheds extend about 150 ft. on either side of the building and uncovered platform 700 or 800 ft. beyond. The level of Upper Terrace Street is above the track, and the station is approached by a bridge across the track, which enters the second story of the tower.

The material is a local stone, brick and terra cotta.

The building was designed by R. H. Robertson and A. D. Manning, Associated Architects, of New York City.

Bids for Steel Gun-Forgings and Armor-Plates.

A BRIEF note was made last month of the opening of bids for steel gun-forgings and armor-plates. The Secreary of the Navy has issued the following list of the prices offered:

PROPOSALS FOR STEEL GUN-FORGINGS.

Kind of forging.	Calculated tons.	Bethlehem Iron Co. Price p. ton.	Cambria Iron Co. Price p. ton.	Midvale Steel Co. Price p. ton.
Tubes and jackets for 6-in. breech-loading rifle	146.418	$672.00	$800	$885
Tubes and jackets for 8-in. breech-loading rifle	31.804	716.80	700	1,008
Tubes and jackets for 10-in. breech-loading rifle	426.888	761.60	650	1,232
Tubes and jackets for 12-in. breech-loading rifle	59.470	806.40	750	1,232
Hoops for 6-in. and 8-in. breech-loading rifle	140.474	672.00	800	885
Hoops for 10-in breech-loading rifle.	330.024	761.60	650	1,232
Hoops for 12-in. breech-loading rifle	49.796	761.60	750	1,232
Trunnion-bands	15.292	672.00	800	1,680
Plugs and mushrooms for all calibers	20.864	672.00	650	885
Total price		$902,230.79	$851.513	1,397,240

PROPOSALS FOR STEEL ARMOR-PLATES.

Kind of material.	Estimated tons.	Bethlehem Iron Co. Price per ton.	Cleveland Rolling Mill Co. Price per ton.
Side armor for *Puritan*	734.7	$510	$600
Side armor for *Amphitrite* and class	1,066.8	510	600
Turrets and pilot houses for 4 monitors	835.8	575	600
Smoke-pipes and ventilators for 4 monitors	266.3	575	600
Armor for breastworks for 2 armored vessels	680.0	575	600
Armor for turrets, conning towers and ammunition tubes for 2 armored vessels	485.0	575	600
Part of side armor for 2 armored vessels.	364.0	500	600
" " "	468.0	575	600
" " "	272.0	600	600
" " "	196.0	600	600
Rolled plates, protective deck armor and gun shields	1,135.0	490	600
Turret and side armor-bolts and steel accessories	181.0	650	600
Small armor bolts, steel	6.0	650	600
Tubing and washers, wrought-iron	12.0	180	600
Total price		$3,610,707	$4,021,560

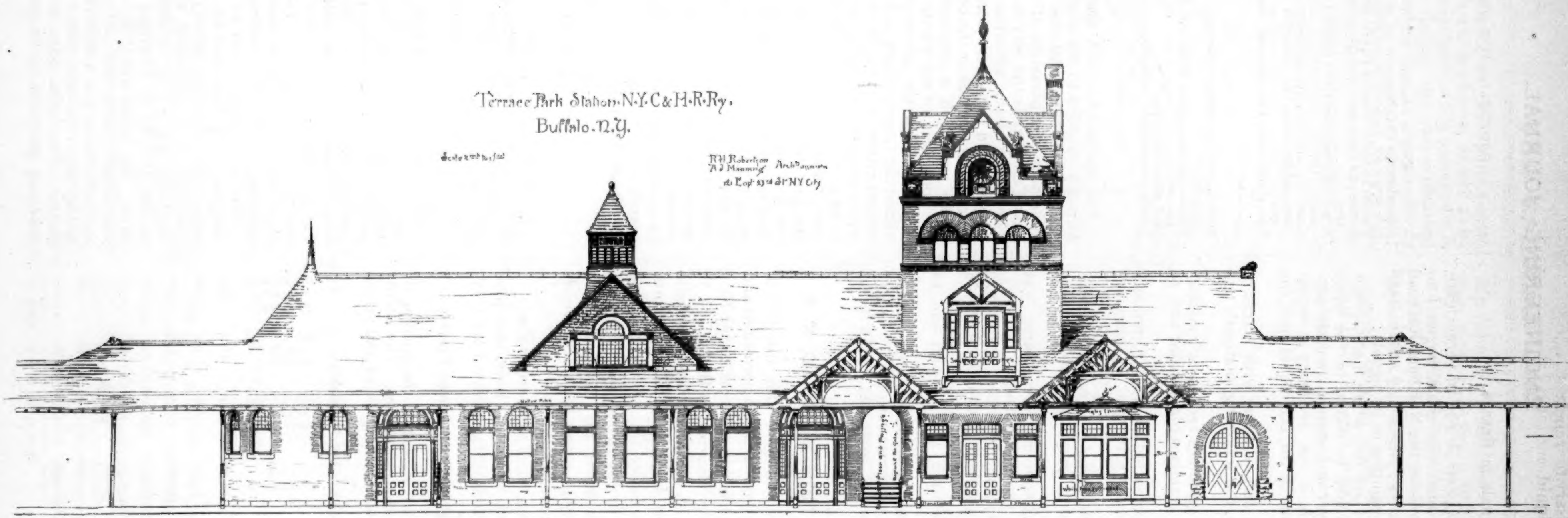
The contract for both armor-plates and gun-steel was formally awarded to the Bethlehem Iron Company, April 14. The Secretary of the Navy makes the following statement in explanation of the award: "The Bethlehem Iron Company is the only bidder for the whole contract. The theory of the advertisement was that the Government wanted the lowest price for the whole work (paying more or less for one or the other being immaterial, so long as the entire job is obtained at the lowest total price), the total sum for the whole job being the material thing. With this view the advertisement was framed so as to obtain the largest range of bidding, allowing a person to bid for either or for both; but the total sum which the whole should cost the Government being the matter alone to be considered. The two lowest separate bids for the two classes being that of the Cambria Iron Company for the gun steel and the Cleveland Rolling Mill Company for the armor-plate amount to $4,873,073. That of the Bethlehem Iron Company for the same classes amounts to $4,512,938. They are the lowest bidders for the work by the sum of $360,135. Since the bidding has taken place the Bethlehem Company has offered to reduce the prices on the gun-steel, so as to make that company the lowest bidder for each of the separate classes. This may be done under the circumstances, although I should not permit it if I did not consider them, on other grounds, entitled to the award."

The New War-Ships.

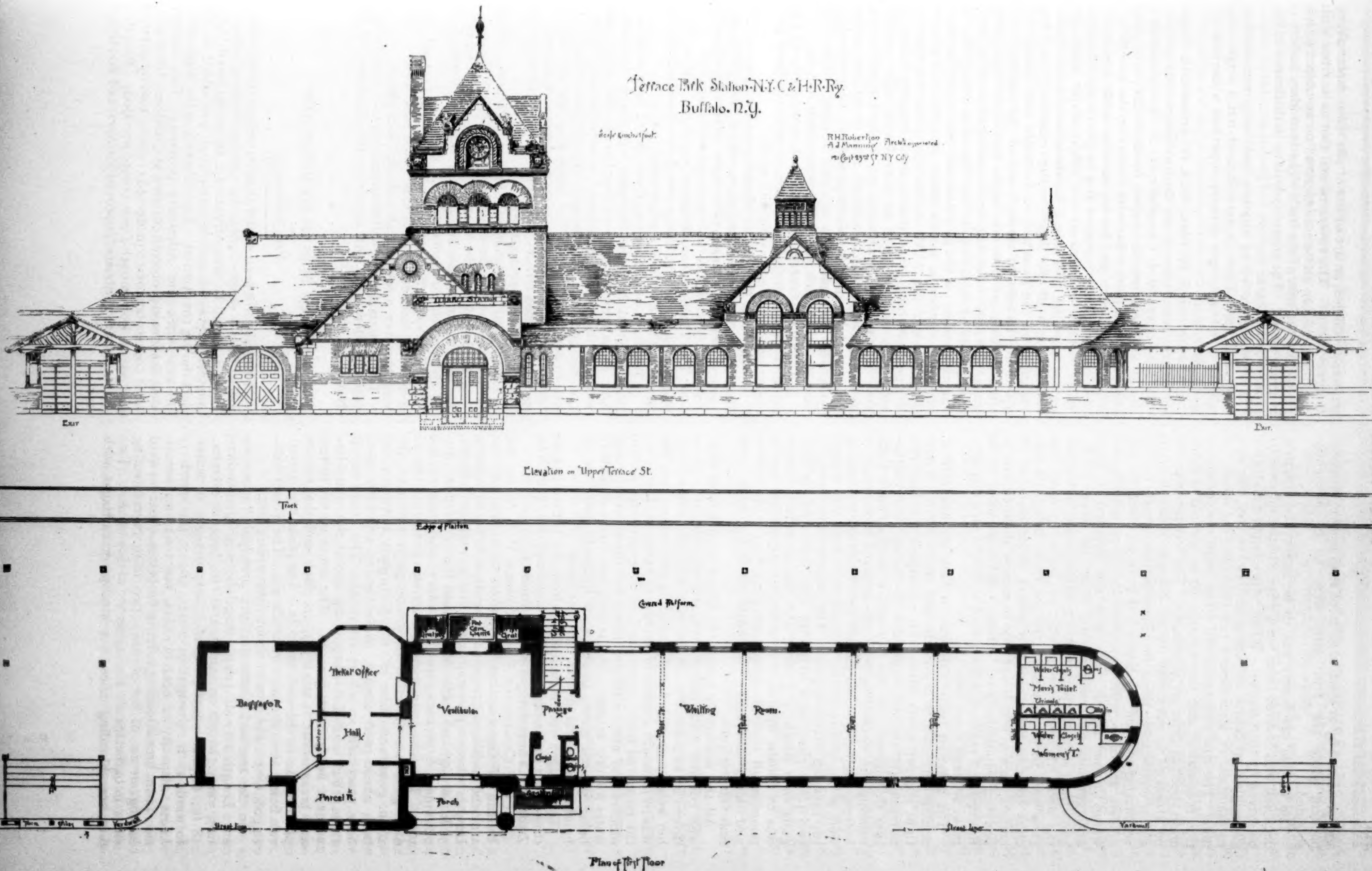
IN Washington, early in April, the designs presented for the two new armored ships authorized the act of August 3, 1886, were opened by the Secretary of the Navy. One of these vessels was to be an armored cruiser, the other a battle-ship, and the general features of each type were to be as follows:

The armored cruiser was to have a double-bottomed steel hull, unsheathed and divided into numerous water-tight compartments, fitted with a powerful pumping apparatus, and finished with a perfect drainage and ventilation system throughout. She was to be fitted with a ram-bow and was to have a steel-armored deck which would run the whole length of the ship and cover the boilers, engines and magazines. Two-thirds full sail power was required on two or three masts, each with a protected top, carrying one or more machine or rapid-fire guns.

The main battery was to have four 10-in. guns, each weighing 26½ tons, and six 6-in. guns each weighing 5 tons. The secondary battery was to be composed of four 6-pounder, four 3-pounder, and two 1-pounder Hotchkiss rapid-fire guns, four 47-millimeters and four 37-millimeters Hotchkiss revolving cannon, and four Gatling guns. The vessel was to be equipped with a torpedo and search-light outfit, and the guns were to be so arranged as to obtain for bow and stern fire the greatest horizontal and vertical command consistent with other essential conditions. The 10-in. guns were to load in at least two positions, and were to be served and handled by power,



Elevation on Track Side


Terrace Park Station·N·Y·C & H·R·Ry.
Buffalo. N.Y.
R.H. Robertson
A.J. Manning
Arch'ts associated
Exit
Ent.
Elevation on Upper Terrace St.
Track
Edge of Platform
Covered Platform
Ticket Office
Baggage R.
Hall
Vestibule
Passage
Waiting
Room.
Parcel R.
Porch
Men's Toilet
Urinals
Water Closets
Women's T.
Street Line
Yardwall
Plan of First Floor

and protected by at least 10½ in. of steel armor, properly backed, while the 6-in. guns were to be efficiently shielded.

The motive machinery was to be below the armored deck and well covered from hostile fire, and the ship was to be driven by twin screws. When fully equipped and with all weights on board, excluding the reserve coal, she was to maintain 17 knots speed per hour over the measured mile. The coal endurance had to be large, the consumption economical, and the distance to be covered at moderate speed as great as practicable. The furnaces were to be arranged to work with forced draught when desired, air for combustion being furnished independently of the ventilating system. Quarters had to be provided for 270 officers and men, with provisions for three months and water for one month. The ship was required to have arrangements for being steered either by power or by hand from several independent positions upon and below the deck. A sufficient number of boats to carry the crew were to be furnished, two of them being second-class torpedo boats and two others steam launches or cutters, each of which was able to mount, shielded, one 3-pounder rapid-fire gun. These conditions were to be fulfilled at a maximum draught of 22 ft. and on a displacement of about 6,000 tons.

The armored battle-ship was to have an unsheathed, double-bottomed, steel hull, divided into numerous water-tight compartments, fitted with a complete and powerful pumping system, and supplied with drainage and ventilation throughout. A ram bow and a steel-armored deck running the whole length of the ship and protecting the boilers, engines and magazines were essential features, as well as one or two military masts, each with a protected top carrying machine-guns. The main battery was to be two 12-in. guns, each weighing 46½ tons, and six 6-in. guns, each weighing 5 tons; and the secondary battery was to consist of four 6-pounder, six 3-pounder, two 1-pounder, all Hotchkiss rapid-fire guns, four 47-millimeter and four 37-millimeter Hotchkiss revolving cannon and four Gatling guns.

All the machinery was to be below the armored deck, well covered from hostile fire, and the ship was to be driven by twin screws. When fully equipped and with all her weights on board, not including the reserve coal, she was to maintain a speed of at least 17 knots per hour over the measured mile. Quarters were to be provided for 270 officers and men, with provisions for three months and water for one month, and the ship was to be capable of being steered either by steam or hydraulic power, or by hand from several independent positions.

Ten designs were received, five from the United States, three from England, one from France and one from New Zealand. These designs were as follows:

1. Chief Constructor T. D. Williams, U. S. N., for the Bureau of Construction, submitted a design for the armored cruiser, the principal dimensions being as follows: Length between perpendiculars, 310 ft.; extreme breadth, 54 ft.; draught of water above base line, 21 ft. 6 in.; displacement, 6,600 tons; speed, 17 knots; coal capacity, 800 tons. The four 10-in. guns are carried in turrets, the six 6-in. guns are mounted on center-pivot carriages, the 10-in. guns and three of the 6-in. guns having a fire both ahead and abeam, while the 13 rapid-fire guns have practically an all-around range. The armor belt is 17 in. thick and 6 ft. deep, being above the water-line when at her greatest draught. The armor on the turrets and breastworks is steel, 10½ in. thick, and that on the pilot house is reduced to 10 in. Ten boats are carried, two being second-class torpedo boats. The vessel bark-rigged, with a sail area of about 7,000 square feet.

In the armored battle-ship the principal dimensions are: Length over all, 318 ft.; length between perpendiculars, 300 ft.; length on load line, 310 ft.; breadth extreme, 58 ft.; displacements in tons, 6,600; draught of water, forward, 21 ft.; draught of water, aft, 23 ft.; speed, 17 knots; capacity of coal bunkers, 800 tons; armament, two 12-in. breechloading rifles in barbettes, those forward having an arc of fire of 300°; two 10-in. breechloading rifles in barbettes aft, having an arc of fire of 280°. Two 6-in. breechloading rifles on central-pivot carriages, with segmental shields, an arc of fire of 180° from direct ahead to direct astern. The two 12-in. and two 10-in. rifles, with one 6-in. rifle, can all be concentrated on an object within 22 ft. from the side of the hull. The secondary battery is as given above. The armor on hull is, in thickness, 12 in.; around barbettes, 12 in.

The boats are 10 in number, two being second-class torpedo boats. There is no sail used, but a single mast will be fitted with two military tops and a derrick for handling boats.

2. Constructor S. H. Pook, U. S. N., presented a design for an armored cruiser of the central-box casemate type.

3. Lieutenant W. I. Chambers, U. S. N., submitted a design for the armored cruiser, in which the 10-in. guns are grouped in pairs in barbette turrets on the middle line of the vessel, each pair having unobstructed arcs of fire of 280 degrees, and mounted at a height of 24½ ft. above water. There are also six 6-in. rifles, two of which are on the spar deck, and have a fire ahead, astern and abeam, through arcs of 180 degrees, the remaining four being mounted on the gun-deck so as to fire two ahead, two astern and two abeam through arcs of 135 degrees. On the gun deck are mounted eight 6-pounder rapid-firing guns, with arcs of 140 degrees, so arranged as to be easily transported to fire all eight from the same broadside. At the extremities on the gun deck are four 47-millimeters revolving cannon in towers which give them nearly 180 degrees arc of fire. Above the spar deck is a spacious bridge extending from the forward conning tower to amidships, where it exte ds from side to side. At the ends of this bridge, amidships, are 3-pounder rapid-firing guns so arranged as to enable all four to be fired ahead, astern and abeam. Two Gatlings and two 1-pounder boat guns are also mounted on this bridge. The side armor is 11 in. thick and the barbette armor 10½ in.

4. Captain L. Tonns, of New York, presented a design of novel character for the cruiser; it was to be lined both inside and outside the skin with wood.

5. Mr. F. L. Norton, of Washington, designer of the Norton lifeboat, presented plans which, though incomplete in military features, offer some novel suggestions as to the construction of hull and armored citadel.

6. The Thames Iron Shipbuilding Company, of London, England, offered designs for both vessels, similar to others built for several foreign countries.

7. The Barrow Shipbuilding Company, of Barrow-in-Furness, England, Mr. John, designer, submitted designs for both ships, the armored cruiser having the 10-in. guns mounted in seperate box-shaped, armored casemates on a covered gun deck, so arranged as to fire two ahead, two astern and two abeam. The battle-ship has the two 12-in. guns mounted *en echelon* on separate turn-tables in a central armored citadel, the armor of which extends from the gun to the spar deck only.

8. Mr. Watt, Birkenhead, England, presented a design for a battle ship on the central-citadel. battery plan.

9. M. Grandjean, St. Nazaire, France, submitted plans for the cruiser, similar in character to several vessels built by the French Government.

10. Captain M. S. Clayton, Auckland, New Zealand, sent a drawing, intended to embody some new ideas. This was, however, a rough draft only and incomplete.

The various designs will be submitted to a board which will consider them and report to the Secretary of the Navy.

New Ships for the British Navy.

(From *Engineering*.)

IT has already been stated that no important new ships are to be laid down during the coming financial year, although, as will be presently shown, an exceptionally large number of vessels will be completed and added to the fleet during that period. The following is the programme of new work the Admiralty proposes: Two 20-knot steel-bottomed protected cruisers, at Chatham; three 19¾-knot copper-bottomed protected cruisers, two by contract and one at Portsmouth; one composite sloop (*Buzzard*), six composite gunboats (improved *Rattlers*) and one *Grass-*

hopper class. Another vessel of the *Buzzard* class, the *Daphne*, has already been commenced at Sheerness, although she was not included in former estimates.

With regard to the gunboats and sloops referred to, we are informed that a careful inquiry into the composition of our squadrons abroad has made it clear that too large a proportion of our naval strength is absorbed by small vessels which, however well adapted for police purposes in time of peace or for operation in shoal water, would be of little value for the protection of our commerce on the high seas. All the vessels above referred to will have, we are told, a speed equal to, if not in excess of, any of their class elsewhere, and will therefore be a match for anything of like displacement which they might encounter.

The two 20-knot steel cruisers are the most noteworthy vessels on the programme for next year. The following are the chief particulars as given by the Admiralty statement:

Length, 265 ft.; breadth, 41 ft.; displacement, 2,800 tons; speed on measured mile, with 400 tons of coal, and fully equipped, 20 knots; ocean speed, 17 to 18 knots; radius of action at 10-knot speed, 8,000 knots. The vessels will have a protective steel deck extending from stem to stern, and sheltering the boilers, magazines, steering gear, etc. Vertical (inverted cylinder) triple-expansion engines are to be fitted, special arrangements of armored coamings being built for the protection of the cylinders. Above the protective steel deck the space will be minutely subdivided, coal bunkers, cofferdams, etc., being built as is usual in vessels of the protective class. A double bottom on the cellular principle, adapted for water ballast, will be fitted. The armament will include six 6-in. B. L. R. guns on center-pivot mountings, nine 6-pounder rapid-firing guns, machine guns, six torpedo tubes (all under cover). The bow will be strengthened for ramming in the usual manner. In all respects the vessels will be made suitable for independent sea service, and for being driven at high speed in rough water. They will have only fore-and-aft steadying sails.

The three copper sheathed 19¾-knot cruisers will be like the vessel just described, except that it has been decided to vary them in the following particulars:

To wood-sheathe and copper the bottoms, so as to make the vessels capable of remaining afloat for long periods without serious fouling and consequent loss of speed, and to adopt horizontal engines, placed entirely below the protective deck. These changes involve an increase in displacement and a slight decrease in maximum speed, which are accepted in view of the special services for which the vessels are intended. In armament protection, and all other qualities, the conditions are the same in these as in the steel-bottomed ships

Turning from this very modest programme of new work for the coming year, we find that it is hoped the following vessels will be completed during the coming year and added to the effective list. The list contains ten armored ships, viz.; the *Rodney*, the *Howe* and the *Benbow*, of the *Admiral* class, the *Warspite* and *Hero*, and five contract-built belted cruisers. The protected ships will be the *Severn* and the *Thames*. There will be seven torpedo cruisers, six of the *Archer* class, and the *Fearless*. There will also be three torpedo gunboats of the *Rattlesnake* class, and finally three composite sloops of the *Buzzard* and *Rattler* class. This makes a total of 25 vessels in all. In addition to these, we are told, the *Camperdown* and *Forth* will be nearly finished, and the *Anson* will be approaching completion.

With regard to other ships, the *Immortalité* and *Aurora* will be far advanced. The former is to have £100,585 spent on her next year, after which there will remain the sum of £28,328 to complete; the grand total cost of ship and armament being estimated at £301,902. This vessel is an armor-plated cruiser of 5,000 tons, now building at Chatham. The *Aurora* is a similar ship, and will be in about the same stage of completion at the end of the year. The *Renown* and the *Sanspareil* are to be delivered in October of next year, and the two big ships *Trafalgar* and *Nile* (armor-plated turret ships) remain the chief cause of further liability.

To sum up, out of 37 ships building or incomplete it is expected that 26 will be finished by the end of next March, leaving only nine out of the programme for 1885. There will be in addition two other ships not belonging to that programme, to be thereafter finished. * * * *

The question should be asked, why some important vessels are not to be laid down to carry on the work now so rapidly being completed?

Two possible answers to this question occur to us. Either the Admiralty is afraid to ask for the money, or else the constructive department is unable to advise what type of ship is to take the place of the existing first-class battle-ship. The former solution to the problem is one very possible, and strictly in accordance with precedent; although Lord George Hamilton has on occasions shown a sturdiness of purpose that is somewhat rare amongst First Lords. The alternative proposition would open up quite a new feature in naval administration, and we must say that Mr. White has never displayed any notable diffidence as to his professional abilities. There is, however, a third point of view from which the possibilities of the situation may be surveyed. The constructive department may be quite convinced as to the course which they would recommend, but the naval element in the management of affairs may be quite as satisfied that their views are unsound. Such a state of affairs would lead to a dead-lock which only the supreme authority of the Board could overcome, and that authority, as we know, has already been invoked in the case of of the *Nile* and *Trafalgar*. It will perhaps not be rash to say that had the Constructive Department had their own way we should now have large vessels without side armor on the stocks, battle-ships of the Italian type, but of improved design, and we certainly should not be building the *Trafalgar* and *Nile*. * * *

Another subject dealt with in the present estimates is the depreciation of the fleet, and the following, subject to certain necessary restrictions, is set down in Lord George Hamilton's statement as a reasonable scale on which to fix the annual depreciation for the different classes of vessels:

1. On armored, protected, and partially protected iron or steel vessels, for 22 years from date of completion, 4 per cent.

2. On corvettes, sloops, torpedo cruisers, gun vessels, gunboats, troop-ships, and other vessels, for 15 years, 6 per cent.

3. On torpedo boats, steam launches, etc., for 11 years, 9 per cent.

4. On small vessels, tugs, and yard craft, for 18 years, 5 per cent.

5. On guard, receiving, training, and harbor vessels, for 22 years, 4 per cent.

The Camperdown; A New British Armor-Clad Ship.

THE following description from the London *Times* of a new armor clad ship, which has just been completed and made its trial trip, will probably interest many readers in this country at the present time. Her keel was laid down December 18, 1882, and she was launched November 22, 1885, having thus taken three years to build. She belongs to the *Admiral* class of battle ships, which comprise the *Camperdown, Collingwood, Benbow, Anson, Howe* and *Rodney*, the whole of which, with the exception of the *Anson* have made successful trials of their machinery. She measures 330 ft. between perpendiculars, 68 ft. 6 in. in extreme breadth, and 26 ft. 2 in. in depth of hold, her mean draught being 26 ft. 9 in., and her displacement 10,000 tons. She is protected amidships by a water-line belt 150 ft. long, 18 in. thick, 7 ft. 6 in. deep, of which 2 ft. 6 in. are intended to be above water when fully equipped; the whole forming, with athwartship bulkheads at the ends, a central citadel for the protection of the vital parts of the ship. The *Camperdown* will carry four 13½-in. 67-ton breech-loaders in two barbettes placed forward and aft, and covered by 14 in. sloping compound armor; and six 6-in. 5-ton breechloaders under the spar deck. She will be manned by a complement of 430 officers and men. The engines and machinery have been manufactured and fitted on board by Messrs. Maudslay, Sons & Field, of London. They consist of two sets of three-cylinder compound in-

verted engines, having two low-pressure cylinders placed together. Each set of engines has one high-pressure cylinder 52 in. in diameter, and two low-pressure cylinders 74 in. in diameter, the stroke being 45 in. The cylinder linings are of Whitworth's fluid compressed steel. The crank shafts, which are made of steel and hollow, are interchangeable, the cranks being placed at an angle of 120 degrees with each other, while centrifugal lubricators are fitted to the crank pins. The surface condensers, together with the air-pumps and hot wells, are made of gun-metal, and the condensers are constructed so as to be worked as common condensers if required. The condensers contain 11,550 brass tubes, having an external diameter of ¾ in., with a cooling surface of 17,000 sq. ft. The cold water is circulated through the main condensers by centrifugal pumps, each driven by a pair of inverted engines having a stroke of 15 in., the diameter of the cylinders being 12 in. and that of the fans 4 ft. These pumps are also arranged for pumping water out of the ship in case of accident, provision being made for a direct suction of the water from the bilge instead of its having to pass through the condensers. Each set of engines has two air pumps, 30 in. in diameter, worked by wrought-iron beams by means of levers from the cylinder cross-heads .The bilge pumps are also worked by these beams. The boilers are 12 in number, and are placed in four separate compartments forward of the engine-rooms. The boilers are 12 ft. 4 in. wide, 14 ft. 1 in. high, and 9 ft. 11 in. long, having in all 36 furnaces, 3 ft. 2 in. in diameter and 7 ft. long. They are fitted with 3,432 tubes, 2¾ in. in diameter and 7 ft. long, and possess a collective area of fire-grate of 800 sq. ft. The tube plates and combustion chambers are made of the best Yorkshire iron, and the shells of Siemens-Marten steel. The safety valves are of the latest approved type, with spiral springs of square steel, and loaded to 90 lbs. per square inch. The stop valves are placed horizontally and are self-acting. As is now customary, the stokeholds are arranged for working with forced draught when the engines are required to exert their full power, and air-wells are fitted at all the exits. For the purpose of maintaining the air pressure, eight fans, 5 ft. in diameter, are provided, worked by small horizontal engines. Two are located in each boiler room, while means are provided for shutting each one entirely off to prevent the escape of air should the engine break down. Escape ladders and doors have been fitted to the boiler-rooms where possible, the doors flying open immedialely they are released, so as to give those in the stokehold a chance of making good their escape should an accident happen when the boiler room is closed up and under forced draft. In addition to the auxiliary engines already mentioned, there are on board four fan engines with fans 4 ft. 6 in. in diameter, for ventilating the magazines and other parts of the ship.

During the trial under natural draft her immersion was 22 ft. 3 in. forward and 24 ft. 5 in. aft. The machinery worked without giving any trouble to any one concerned from first to last, the bearings remaining cool throughout. With one exception every half-hourly observation showed that the engines were indicating more than 8,000 H. P., and, consequently, in excess of the contract. The mean of the six hours' steaming gave a collective power of 8,605,95, while the ship, as tested by four runs on the measured mile at an early part of the trial, and when the engines were not exerting their greatest power, realized an average speed of 16.3 knots. The reading of the patent log showed that the ship had traveled 112¼ knots during the 6½ hours, which gave her a speed of 17.2 knots an hour. The consumption of fuel during the trial was 2.11 lbs. per H. P. per hour, which, under the conditions mentioned, would enable the *Camperdown* to steam over 2,000 knots.

Another trial was made under forced draft, with even more satisfactory results. Previous to beginning the engine trial the ship was tested as to her steering power, with the following results: Circling to starboard, the tiller was put over from amidships to 34 deg. of helm in 15 seconds, the half-circle was completed in 2 min. 10 sec. and the full circle in 4 min. 53 sec., the diameter of the circle being 630 yards. Circling to port the tiller was put over in 11 seconds, the half-circle was performed in 2 min. 20 sec., and the full circle in 4 min. 42 sec., the diameter being in this instance 650 yards. The vessel was perfectly obedient to the helm, no leverage being necessary to keep her in a straight line. The four hours' trial under forced draft, with 2 in. of water pressure in the stokeholds, was then commenced, the ship being taken long runs to sea to obviate the necessity of turning and so throwing increased strains upon the engines.

No incident of any kind occurred during the four hours to detract from the uniform success of the trial. Two runs were afterward made upon the measured mile, the mean showing a speed of 17.144 knots, which was in substantial agreement with the patent log, which registered a travel of 68¼ knots during the four hours and an everage speed of 17.2 knots. During the day the United Telephone Company, of London, experimented with an instrument for communicating between the bridge and the engine-room. The ordinary voice pipe is impracticable in consequence of the noise produced by the machinery, and a committee has been appointed to consider how the difficulty can be surmounted. The telephonic instrument employed enabled the orders to be heard distinctly while the engines were working at their greatest power, and was favorably received by the officers on board.

Mastless Men-of-War.

In a recent lecture on this subject at the Royal United Service Institution, in London, Eng., by Captain Fitzgerald, R. N., the lecturer said that, though he was of opinion that it would be advisable to unrig immediately all the present ironclads, yet he considered that the carrying out of the idea would be more applicable to future designs for cruisers than to the unrigging of the present single-screw corvettes. He maintained that there was no economy in having masts and sails, as these wore out rapidly and did not save coal, as they stopped the ship more in foul winds than they assisted her in fair. He pressed that the present rigged ironclads would be more powerful fighting machines without their spars and rigging that with them, leaving in their lower masts and turning the tops into small machine-gun batteries. The principal arguments for the abolition of spars and sails in men-of-war, but more particularly in ironclads, were that the weight of masts and sails caused increased immersion and occupied valuable space both on deck and below—space which might otherwise be devoted to warlike stores. They masked, more or less, the fire of guns. There was a probability of wreckage from them fouling the screw in action, and lastly, though perhaps the strongest argument of all, was the fact that the retention of masts and sails in men-of-war diverted so much of the attention, the energy, and the resources of both officers and men from the real work of their profession, and from the study of modern naval warfare, and occupied them in drills and exercises as obsolete for fighting purposes as the bow-and-arrow drill of the Saxons. It was said that a ship's company which was smart at drill aloft was sure to be smart in everything else. This might be true in some cases, but even if it were so, it did not furnish any sufficient argument for keeping up sail-drill. The lecturer discussed at length the objections which would be made to the principles he enunciated, and he claimed that whatever risks there might be in his proposals, these risks were such as occurred even in the carrying of gunpowder, and the necessity of change must be recognized. The duty now before the country was, not to build ships to suit the seamen, but to train the seamen to suit ships in which were the useful inventions of modern time and the innovations of modern science.

A Line-Throwing Gun.

An invention possessing considerable importance in connection with naval matters has recently been successfully tried in the Tilbury Docks, London, The invention is the line-throwing gun of Mr. D. R. Dawson, which is designed to discharge a line, and thus establish communication

between any two given points, which may be the shore and a ship, or they may be two vessels or two objects on land. There are two of the guns, a shoulder gun throwing a line 160 yards in length and a 3½ in. brass gun mounted on a carriage, which will project a line more than a quarter of a mile long. In both cases the gun is loaded from the muzzle, the powder charge being placed in an annular space formed by the bore and a central inner tube running from breech to muzzle. The line is wound in the form of a cop, with a hollow extending its whole length. This cop is placed in a metallic case or shell, and the rear end of the line is drawn from the rear of the shell, threaded through the central tube of the gun, and made fast outside it. The forward end of the line is previously made fast to the case, which is then inserted in the gun. Upon the gun being discharged, the case pays out the line as it proceeds forward, and upon its reaching the object aimed at the line establishes a connection, so that in the case of a ship in distress a rope on board can be made fast to the line and can be hauled ashore or to another vessel. There is no danger of the line being burnt or damaged by the ignited powder because of the center tube and because a special form of gas-check is used. On the occasion in question several rounds were fired from the shoulder gun with 1¾ drams of rifle powder, the line being in each case run out to its full length of 160 yards in a direct course and being afterward hauled in. The ship gun was fired twice with 7½ oz. of powder and 460 yards of line, which was also fully run out. In the second round, at the request of those present, Mr. Dawson laid the gun over one of the jetties at the dock entrance, which was exactly 800 ft. from the firing point. The case crossed the jetty in perfect line, falling into the River Thames beyond at the full range of over a quarter of a mile. There was no question of the success of the experiments, which demonstrated the efficiency of the line-throwing guns and their adaptability to the purposes they are designed to serve. One important feature is that whereas rockets carry their own explosive, which sometimes deteriorates and causes the rocket to fail, the line gun is charged with powder at the moment of use, so that the charge can always be fresh and dry. The shoulder gun is also intended to be used on land in cases of fire for establishing communication for saving life. Messrs. M'Alister and Co., of 21 West India Dock-road, London, are the sole agents for this useful invention.—*London Times.*

Trial of a New Torpedo Gunboat.

(From the *London Times.*)

The *Rattlesnake*, torpedo gunboat, built and engined by Messrs. Laird Brothers at Birkenhead, has just made a contractor's three hours full-power trial of her machinery at Portsmouth, previons to being received by the Admiralty. She is of 450 tons displacement, and is the first of her class. Hence the interest which attaches to her performances under way. The other vessels of the class are the *Spider*, *Grasshopper* and *Sandfly*, the whole of which are being constructed at the Royal dock yards, the *Grasshopper* at Sheerness and the others at Devonport, while the machinery is being made by Messrs. Maudslay, Sons & Field. The *Rattlesnake* is 200 ft. between perpendiculars, with a beam of 23 ft. and a depth of hold of 13 ft. She is built entirely of steel, and is fitted with a half poop and forecastle, and a conning tower with a conning bridge erected over it. In speed she equals the first-class torpedo boats; while, as she stands well out of the water and has good accommodations between decks, in seaworthiness, ability to keep the sea, and comfort for the crew, she is vastly superior. Her offensive power is also greater. In addition to one torpedo tube through the bow and another through the stern in a fore-and-aft line, and one on each broadside forward capable of training through 90 degrees, she will mount a 4-in. 25 cwt. central pivot breechloader, capable of penetrating 8 in, of armor. This will make her a formidable antagonist to all but heavily protected ships of war. The gun will be surrounded by a steel screen attached to the carriage for the defense of the gunner against machine guns and rifle fire. She will also carry 6 three-pounder Hotchkiss quick-firing guns. Above the bridge an electric search light will be fitted. In engining the *Rattlesnake* the paramount object with the contractors has been to reduce all weights to a *minimum* consistent with efficiency. The contract power of the engines is 2,700 collective H. P.; and when it is considered that this enormous force is contained in a snake-like craft of only 450 tons, while the engines of the corvettes of the C class, of 2,380 tons displacement, develop only 2,430 H. P., the character of the problem which the marine engineer has had to grapple will be readily recognized. The boilers are protected at the forward end and at the sides by coal bunkers capable of stowing 90 tons of fuel, while the engines, which are not divided by bulkheads, are protected by extra thick plating on the sides of the vessel. In the design of the machinery advantage has been taken of the experience derived from the performances of the torpedo fleet, and consequently there are various improvements. The propelling machinery consists of two sets of vertical triple-expansion three-crank engines, having cylinders of 18½, 27 and 42 in. diameters respectively, with a stroke of 18 in., and capable of exerting 2,700 H. P. at about 310 revolutions. The total condensing surface of the condensers amounts to 4,000 square feet. The framing of the engines is entirely composed of steel, and this material has also been largely employed in the construction of the machinery throughout. The crank and other shafting has been manufactured of Whitworth special steel, and is hollow throughout. The propellers are made of solid manganese bronze. They are three-bladed, and have a diameter of 6 ft. 6 in., and a pitch of 7 ft. 6 in. The boilers, four in number, are fitted in two stokeholds, which are wholly separate, so that, in consequence of the duplication adopted, there would be a chance of the *Rattlesnake* making good her escape though partly disabled in her machinery. They are of the locomotive type, but a new principle has been introduced of constructing them with wet bottoms, and with large conical-shaped tubes placed between the furnaces. In addition to increasing the heating surface, this plan affords an efficient means of circulating the water in the boilers. The working pressure is 140 lbs. to the square inch, while the heating surface is about 5,000 ft., and the area of fire-grate 122 ft. The stokeholds are fitted with four fans for providing the forced draught, with which the vessel will be exclusively driven. Besides supplying the propelling machinery, Messrs. Laird have fitted on board a dynamo engine for the search light, an air-compressing machine for the torpedo service, and a steering engine (made by Forrester & Co.), which works very powerful gear in the after part of the vessel below the water-line. This gear is capable of being readily converted into hand gear. The same contractors have also fitted the torpedo tubes and gear, the gun mountings, and other work, in compliance with an extra contract intrusted to them by the Admiralty. In addition to the 90 tons of coal already mentioned, the *Rattlesnake* will carry engine-room stores for six months. Two light spars will be carried for signaling purposes. These torpedo-boat catchers or gunboats are both faster and more formidable than anything of the gunboat class yet designed, and are expected to prove an effective check to the operations of torpedo boats in war.

Considerably greater difficulty attaches to the trials of these small craft, in consequence of the lightness in reciprocations, the want of space and the comparative fewness of the men in charge, than to the trial of a full-sized battle-ship. This will serve to explain the causes of the many failures through which they pass before a thoroughly satisfactory success can be recorded. It will consequently create no surprise to learn that the *Rattlesnake* did not achieve the results notified below until various weaknesses had been rectified, and sundry readjustments of the slides and other moving parts had been made. The trial was watched by Mr. Alton and Mr. Maystow on behalf of the Steam Reserve and the dockyard, and by Messrs. Shapcott and Smith of the Controller's Department, the engines being under the charge of Mr.

Bevis, Jr., as representing the contractors. The vessel was brought down to her load draught by means of iron ballast—namely, 6 ft. 9 in. forward and 9 ft. 11 in. aft. After a short preliminary run the *Rattlesnake* proceeded on a three-hours', official, full-power trial, at the end of which the following mean results were attained: Steam in boilers 136 lbs., which was less than the engines could have utilized; vacuum, 25 in; revolutions, 311 (starboard) and 308 (port); mean pressures—starboard, 59 lbs. high, 28 lbs. intermediate, and 13 lbs. low; port, 58 lbs., high, 28 lbs. intermediate, and 11 lbs. low; indicated H. P., 1,424.10 starboard, and 1,294.17 port; thus giving a collective indicated H. P. of 2,718.27, which is slightly beyond the contract. The mean of six runs upon the measured mile gave a speed of 18.779 knots. It remains, however, to be stated that the weather was somewhat boisterous for so small a craft, the wind blowing from tho southwest with a force of over 3, the result being a probable loss of ten revolutions per minute. On the conclusion of the steam trial the steam steering gear was tested, when it was found that the helm could be put hard over from hard over in 20 seconds. The craft behaved very well in spite of the weather. Though the sea broke over her in clouds of spray, and she proved at times somewhat lively, the vibration was confined to the extreme ends, and there can be no doubt that she will provide a fairly steady platform for the gun which she is intended to carry.

A New Spanish War Vessel.

(From *Engineering*.)

UNDER the name of the *Reina Regente*, Messrs. James & George Thomson, Clydebank, have just launched an armored cruiser which they have built to the order of the Spanish Government. The new ship has an armored or protective deck 4¾ in. in thickness, and the armament is to consist of four 24-centimeter Hontorio 21-ton guns, six 12-centimeter Hontorio guns, six 6-pounder guns of the Nordenfelt type, two 37-millimeter Hotchkiss revolving guns, and a dozen other small guns and five torpedo tubes. The builders have also provided for a speed of 20½ knots and for a radius of action of 12,000 knots.

Measuring 330 ft. in length, and built entirely of steel, the *Reina Regente* will have a displacement of about 5,000 tons for ordinary sea-going purposes, but when fully equipped her displacement will amount to 5,600 tons. In addition to the protection provided by the armored deck, she has an excellent means of defence in her extensive and very minute internal sub-division, there being no fewer than 156 water-tight compartments. Of these, 60 are beneath the armored deck, and there are 83 between that deck and the one above it, that is to say, in that part of the ship which is situated "between wind and water." Most of those 83 water-tight compartments are to be used as coal bunkers, so that any shell or shot that may strike the ship along that belt of her exterior is not likely to get beyond the particular bunker which it may possibly penetrate, consequently it will take many shots to disable the ship.

The *Reina Regente* is a twin-screw ship, and she is to be driven by means of two sets of horizontal engines of the triple-expansion type, of an aggregate of about 12,000 indicated horse-power. These engines are to occupy separate water-tight compartments. Steam will be supplied to them by means of four large boilers, which will also occupy separate water-tight compartments. In addition to those boilers there will be two of Messrs. Merryweather & Co.'s boilers intended for raising steam rapidly in cases of emergency. They will be placed at some distance above the water-line, and they will have connection with all the auxiliary engines of the ship. Besides the two sets of main engines for propelling vessels, there will be between forty and fifty other engines, including two starting enengines, others for working four 14-in. centrifugal pumps (by Messrs. Drysdale & Co., of the Bon-Accord Engine Works, Glasgow), bilge and fire and feed pumps, ten fandraught engines, two electric light engines, a capstan engine by Harfield, steering engine and boat-hoisting and ash-hoisting engines by Messrs. Muir & Caldwell, Glasgow.

The pumping arrangements of this highly complicated modern war-ship are on a very complete scale. All the 14-in. centrifugal pumps are connected to a main pipe which runs from stem to stern of the ship, and into which there are branches from every compartment, these being so arranged that the compartments are always in immediate connection with the pumps, so that if any of the compartments should become flooded they are immediately pumped out, while if the water attempts, in the shape of a return current, to enter a compartment from its respective pipe, it is at once prevented by means of an automatic valve. By these arrangements it is only necessary for the engineer to keep his pumps in action, and any water which may happen to get into any compartment will be pumped out without the slightest attention. Before leaving the pumping arrangements we ought to mention that the vessel has a double bottom which extends from side to side and throughout her whole length.

Not only is the *Reina Regente* to have great speed, but she is also to have great rapidity of turning, a point to which much attention has been given in designing this new cruiser, in which there has been fitted a sternway manœuvering rudder designed and patented by Messrs. Thomson & Biles. This type of rudder has given most extraordinary results in the manœuvering of the Russian torpedo boat *Wyborg* and the Spanish torpedo cruiser *El Destructor*, both of which were built and equipped at Clydebank last year. With the improvements that have sincc been made in this rudder, it is confidently believed that the *Reina Regente* will give even still better results.

In this new cruiser the quarters of the officers and the crew will occupy the whole of the main deck—the accommodation to be provided being for 50 of the former and 350 of the latter. Right forward on this deck there are two torpedo tubes; there is also one right aft, and one in each broadside amidships. On the level of the main deck, but projecting beyond the side of the ship, there are four gun towers. The two forward ones fire each 5° across the bow, and to within 30° of right aft; while the the after ones have a similar range round the stern. The remainder of the armament is placed on the upper deck, at the fore end of which there is a platform raised about 4 ft. above the deck, and upon this two of the 21-ton guns will be placed. These guns will fire right ahead, and to within 40° of right aft. The supports of these enormous guns extend right down to the bottom of the vessel, and the ammunition is supplied to them through two heavily armored hoists. The other two 21-ton guns are placed on a similar raised platform aft, and between the two platforms and ranging along both sides of the ship, there are placed the six 12-centimeter guns, two of which fire right forward, two right aft, and the other two having a range of 140°. It is stated that the 21-ton guns could with great ease pierce the armor of any of the armorclads afloat or building, and that the other six guns referred to will be able to pierce the armor of any of the belted cruisers now building for the British Navy. Five of the small guns included in the armament of this cruiser are intended for boat and field service, and other four will be worked from the mast-heads. In all there will be 30 guns in the armament of the *Reina Regente*, which, considering the tonnage of the vessel, must be regarded as very formidable.

Magazine and Repeating Rifles in Europe.

A LECTURE was delivered before the Royal United Service Institution in London, February 25, by Captain Walter H. James, R. E., which is reported at length by the London *Times*:

After referring to the experience with magazine and repeating rifles in previous wars, the lecturer said that he looked forward to the now not far distant day when it would be universally acknowledged in England, as it was on the Continent to a great extent now, that in the proper use of long-range fire, in the adequate training of the men to pour in closely delivered showers of lead at distances up to 1,500 yards or over, lay the path to military

pre-eminence. To this training the magazine rifle formed the proper complement. Armed with it the duly trained soldier possessed the power of multiplying his fire enormously at close range or increasing its volume at long range when necessary. Such weapons required careful training both of the officers and men, frequent practice in their use, careful working out of the problems they gave rise to. As to the increased number of rounds the soldier must have, the men could not carry beyond a certain weight, and that weight must in the future consist very largely of cartridges, the soldier's kit must be carried for him, the regimental supply of ammunition must be increased until each man at the moment of battle could have 100 rounds on him, and at least 40 to 50 in the regimental supply.

The lecturer then referred to the question of magazine rifles in European armies. As usual in all military reforms, in the van of progress stood Germany. Immediately after the war of 1870-71, the experiments which had been begun before it broke out were again taken up, and resulted in the Mauser rifle, known officially as Model 71, from the date at which the pattern was definitely decided on. The Mauser was in the hands of five army corps, and before the summer the whole German army would be furnished with it. The rifle unloaded weighed 10 lbs. 2 oz., its calibre was 0.433, its powder-charge 77 grains, its twist in rifling, one in 50, its muzzle velocity 1,410 ft., and with the new Rothwiler powder 1,571 ft. It could be used either as a single loader or a magazine weapon. The magazine is placed under the barrel and holds eight cartridges; these with one in the elevator and one in the barrel made ten in all. There was nothing particular worth drawing attention to in the construction of the lock or magazine system. To shut off the magazine the breech was opened and a small arm on the left side of the rifle pushed forward; this moved the other end of the cam, of which it formed a part, forward into the underneath portion of the elevator, and thus fixed it so that it did not fall down when the magazine was closed. The Mauser repeater, M. 71-84, fired the same cartridge as the Mauser rifle, M.-71, but latterly experiments had been made with an improved one containing 89½ grains of compressed powder and a steel covered lead bullet. With this cartridge the muzzle velocity was greater, the penetration considerably more, and the trajectory much flattened, especially at close ranges, than the original. In France no definite solution as to the arm to be adopted had as yet been come to. It seemed, however, probable that the arm would be the "Lobell," called after the name of its inventor, a colonel in the French service. Its calibre was 78 mm. or 0.307 in., and the magazine under the barrel, held eight cartridges. For some years past, however, the French navy had been armed with the Kropatscheck repeater, which differed not materially from the Mauser, except in being a little more complicated. Austria had definitely adopted the Mannlicher rifle. This rifle presented several peculiarities. In the first place the bolt was withdrawn by a straight backward motion, which rendered it much quicker than one in which it was necessary to make a turn, as in most bolt rifles, and hence it could be worked without taking it down from the shoulder. The cartridges were carried packed in tin frames containing five, placed in the case under the bolt-chamber, whence they automatically fell when empty. The cartridges were carried packed in these frames, two being wrapped round with paper, and thus issued to the soldier. The frames weighed 385 grains each—*i. e.*, roughly the weight of a bullet, and cost less than a halfpenny to manufacture. When these cases were placed in the rifle—*e.g.*, when arranged for magazine action, the rifle could not be fired as a single loader, although there was no reason why more than one round should be fired. The cartridge used was the same as that employed for the Werndl rifle, the weapon hitherto in use in the Austro-Hungarian army. Experiments were, however, being made with an improved cartridge giving a higher initial velocity. The weight of the rifle was 9 lbs. 8½ oz., its bullet weighed 371 grains, the rifle calibre was 0.433, its powder-charge 77 grains, and its muzzle velocity 1,437 ft. In Italy experiments had been conducted for some years past, and it had been finally determined to alter the Vetterli rifle (an ordinary form of bolt gun) in accordance with the system known as the Vitali. A magazine was fixed in a central position under the bolt-chamber, in front of the trigger-guard, in which four cartridges packed in a special cardboard box were pushed from above. It, like the Mannlicher, could not be used as a single loader when the cartridges were placed in the magazine. This change was avowedly only a temporary expedient pending the introduction of an improved and probably smaller bore rifle. It only cost $2.12 per piece. The calibre of this rifle was stated to be 0.414, the builet weighed 312 grains, the powder charge was 62 grains, and the muzzle velocity was 1 430 ft. Russia had, like other nations, experimented with repeating rifles, but had not yet definitely settled on a pattern. She had introduced Evans's repeater into her navy. This was distinguished from all others by the large number of cartridges it held, viz., 35, placed in the butt. He did not think, however, it was likely to be introduced into the army. In the meantime, it was stated in the *Times* of February 19, that a form of attachable magazine had been introduced for the Berdan rifle, which held three cartridges, and which could be fitted with a metal case containing five others, or eight in all, and that this apparatus, whatever it might be, could be fixed in less than ten minutes to the rifle. The lecturer added that though, as the *Times*' St. Petersburg correspondent had stated, official remarks had been made against repeaters, yet, nevertheless, the subject was being considered. Sweden had for some time had the Jarmann rifle, with the magazine under the barrel, but it did not possess any special peculiarities or advantages. Its calibre was 0.397. Switzerland had for some years had the Vetterli rifle, which had a rim-fire cartridge, and was scarcely now on the first rank of weapons. Portugal had recently adopted the Guedes rifle with the Kropatscheck breech and repeating action. This rifle was distinguished from all the others mentioned by its small bore and high initial velocity. It would be seen, therefore, that every nation had either definitely adopted, or was experimenting with a view to deciding on some form of magazine. We too had, he believed, made up our minds to follow suit, and he ventured to think our authorities were to be congratulated on having determined to do so rather than to re-arm our infantry with an ordinary breechleader, as was proposed but six months ago. After showing the action of most of the rifles mentioned, he presented two rifles, the one known as the Lee-Burton, the other as the improved Lee. Of each of these rifles a limited number would, he stated, be manufactured and issued to the Army for trial, but no pattern of magazine rifle had as yet been definitely settled on for the future armament of our troops. It was, of course, natural that the universal determination to change the armament of European armies should have given a great stimulus to inventors, and he supposed there was hardly a day than did not bring forth a fresh weapon. For a soldier's weapon we wanted our rifle to shoot well and closely at ranges up to 1,500 or 2,000 yards; to have a flat trajectory within the decisive fighting zone, say 600 yards. These two conditions, other conditions being equal, required a high proportion of weight to area of bullet and a high muzzle velocity. The recoil depended upon the weight of the bullet, the weight of the rifle, and the amount of powder. To fulfill the first without unduly increasing recoil and maintain the second as high as possible it was necessary to have a long, light bullet. He discussed this point at length, and brought to notice bullets covered with steel and copper—German inventions—which rendered lubricators unnecessary. He showed that the compound steel projectile, which had probably been adopted for the Mauser, had great penetrating power. He contended that for the new magazine rifle for England we should have experiments to show the best calibre. Speaking for himself, he liked to see experiments conducted under public conditions with bores smaller than 0.4. It must not be forgotton, he added, that a Government rifle-designer had not the free hand a private one had. He could do as he liked with regard to cartridge-case, powder and bullets. The Government official had to consult two other departments, who might not agree in his views. To

have a rifle which should fulfill the utmost necessary quality in a good military arm—namely, flat trajectory—a small bore was an absolute necessity. Personally, he thought that with our present experience a rifle of 0.32 bore with a bullet weighing 336 grs., and a powder-charge of about 90 to 100 grs., would be a desirable combination. There was one objection usually put forward against small bores—that the bullets fired from them were much more affected by a side wind. As a practical fact, a very important consideration was completely lost sight of—that on the field of battle it was the mass fire of numbers, not the aimed fire of individuals, that had to be taken into consideration, and that therefore lateral deviation, considering that we aimed at broad targets of little depth, was of far less moment than flatness of trajectory. This latter was the great object to be attained in a military rifle, and was of far more importance to the soldier than lateral error, however much that might be objectionable to the match shooter. Flat trajectory—*i.e.*, a long depth of shot-swept space—we must have, and to it we must sacrifice, if necessary, some less needed qualities in the rifle. Moreover, in these days the good old superstition, that having a long-range rifle we should endeavor to prevent it being used until we came within the ranges at which alone the feebler weapons of our forefathers were effective, was really dying out, and long-range fire was now universally admitted, and infantry tactics were based on its employment. Long-range fire, breech-loading rifles, magazine arms, all represented as many steps along the path of increasing expenditure of ammunition. The soldier must carry more cartridges ; he could only carry a certain weight; to get more rounds of ammunition out of that weight it must be further subdivided; therefore the cartridge must weigh less. In short, a small bore was the logical outcome of modern requirements in an infantry arm. As to the rifling, he pointed to the Hebler, which was 0.0052 in. deep, with bands 0.0195 in. wide, and six grooves. So low was the trajectory that the ground would be practically swept from the muzzle to 650 yards.

He referred to experiments which were being made with powders, and expressed the opinion that with the use of compressed powder better-shaped cartridges would be given. He also drew attention to the advantages of smokeless powder, with which the French had lately been making secret experiments. He divided all forms of magazine rifles into four classes, according to the position of the magazine:—(1) In the butt; (2) under the barrel; (3) over the barrel; (4) under the breech. No nation had the first-named, except Russia, in the Evans repeater. The second had been adopted in France (Kropatscheck); Germany (Mauser), Switzerland (Vetterli), Sweden (Jarman), and Portugal (Kropatscheck). It had the advantage of giving room for a number of cartridges, but the very great disadvantage, which it shared with first position, of being difficult to load. Moreover, the balance of the rifle was altered each time a shot was fired. The German rifle was very faulty in this respect, and was, when the magazine was filled, an extremely arkward and ill-balanced weapon, besides being very heavy, weighing 11 lbs. Over the barrel was extremely awkward for the soldier, and in the case of those weapons which had the magazines on one side, was bad for aiming, especially when the sun was shining from the opposite side to that on which it was fixed. Three forms of rifle—the Burton, the Lee-Burton, and the Owen-Jones—had such magazines.

Underneath the breech was, on the whole, the best. The rifle was more compact and far better balanced. It sole disadvantage was the fact that it was difficult to arrange for more than about five cartridges. The Mannlicher, the Schulhoff, the Pieri, the Lee, and the improved Lee, all had this form of magazine. All held five cartridges except the Schulhoff, which would take ten arranged round a drum like a revolver. In conclusion, he stated that he held the view that in a few months the British Army would be in possession of a weapon as much in advance of what other nations had as the present Martini-Henry was in advance of the old "Brown Bess."

Freezing Soft Material for Excavation.

[Paper read before the Society of Arts at its meeting in Boston, Jan. 27, by Mr. Charles Sooysmith, of New York; reported officially in the Boston *Transcript*.]

THE subject on which it is my privilege to address you has become known to engineers as the "Poetsch Freezing Process." The inventor was Mr. Herman Poetsch, a German mining engineer, of no particular note until he conceived and made a practical success of the method which bears his name. He had something to do with sinking a shaft near Ashersleben, in Germany, to a vein of coal where, after excavating about 100 ft., a stratum of sand 18 ft. thick, overlying the coal, was encountered. It occurred to Mr. Poetsch that the great difficulty occasioned by the influx of water through the sand could be overcome by solidifying the entire mass by freezing. To accomplish this, he penetrated the sand to be excavated with large pipes sunk entirely through it, and a foot or two into the underlying coal. These were placed in a circle at intervals of a meter and close to the periphery of the shaft. They were 8 in. in diameter and closed at the lower end. Inside each of these, extending nearly to the bottom and open at its lower end, was a pipe but 1 in. in diameter. This system of pipes was so connected that a closed circulation could be produced down through the small pipes and up through the large ones. An ice-machine, such as is used for cooling in breweries, making ice, etc., was set up near by and used, to keep at a temperature below zero, Fahrenheit, a tank filled with a solution of chloride of magnesium, the freezing point of which is 40° below zero, Fahr. The solution so cooled was circulated through the system of ground pipes described.

Thermometers were placed in pipes sunk into the mass of the sand, and the following results were observed: the temperature of the mass before the circulation of cold liquid was started was 51.8° Fahr. The circulation was kept up and the temperature of the mass was rapidly lowered, so that at the point where this temperature was taken, which must have been not far from one of the pipes, the mass was frozen the third day after circulation had commenced. The freezing took place, of course, soonest about each pipe, beginning first near the bottom, where the inflowing solution was coldest, and extending outward in radial lines. The cylinders, or, more correctly speaking, the frustums of the cones about the pipes, finally met, thus forming a continuous frozen wall, inside of which the material to be excavated was removed without any possible danger from caving in or inflow of water. The freezing, it was found, had taken place 3 ft. into the coal and to a distance 6 ft. outside of the circle of pipes. The circulation of cold fluid was kept up until the excavation and walling-up were complete.

The brief description of the first work suffices to explain the method in its simplest application. Other shafts were undertaken, and where much difficulty is encountered in passing through water-bearing strata, the process for this purpose is now coming into general use in Europe. For the shaft sunk in Germany, ice-machines with a capacity of 15 tons of ice per day—or, more scientifically speaking, capable of producing 1,750,000 thermal units—have been used. Of course, if we knew the specific and latent heat and the conducting capacity of the material we wish to freeze, we could determine exactly the number of thermal units we should have to extract to solidify the mass. Taking a mass consisting of sand and water in the proportions of three to one, at a temperature of 25° centigrade, and assuming that no heat is supplied to the mass to be frozen, we would have to extract 1,168,000 thermal units per cubic yard to freeze the material. This would permit us, with an ice-machine of 30 tons capacity daily, to freeze 54 cub. yds. per day. Knowing the cubical contents of the mass we wish to freeze, we could, in this way, determine the time requisite for the freezing. In most cases, with the machines that would be used, the frozen wall would be formed in 10 or 15 days. As an actual fact considerable cold is dissipated through the earth. It is very fortunate for us, here, that the soils of the earth and still water are comparatively poor conductors, the

conductivity of water being about $\frac{1}{15}$ that of copper. It remains for some of our students, who have the time, to determine the rate through different kinds of earth saturated with water, and also to determine the strength of these when frozen, so that, knowing the strain upon our wall, we may know how thick it must be to surely resist this strain.

In sinking shafts, as the radial lines of conductivity from the pipes converge toward the center of the shaft, and there is no way for the cold to get out, so to speak, the entire mass inside of the circle of pipes freezes while the desired ice wall is being frozen. This, of course, makes the excavation slow and expensive. Frozen sand and water look like sandstone and seem almost as hard. With pick and shovel workmen in the bottom of a shaft will do very well if they average an inch an hour in depth. Of course, the idea of thawing the interior mass at once suggests itself. Pipes for the circulation of hot brine could be inserted before freezing. My impression is, however, that blasting will prove the preferable method.

Probably the greatest service which this invention will render will be in making practicable the construction of subaqueous tunnels which could not otherwise be built.

In applying the freezing method to the construction of a tunnel there are a number of ways of arranging the ground pipes. Where the depth of water is not excessive, and where navigation or current in the stream do not prevent, it would seem simplest and best to put pipes down from above, in vertical or inclined positions, placing them in rows on either side of the proposed excavation. They can be incased in non-conductors of heat, except the portion about which it is desired to freeze. The circumstances where this manner would be practicable will not often occur. We are more likely to meet with cases like that of the Hudson River Tunnel, where the freezing pipes must be put in from the completed portion of the tunnel, reaching forward beyond the heading. The problem of managing these pipes has been the occasion of a great deal of study, because the heading must be kept frozen, and pipes for further freezing must be kept ahead of this. Then, too, the pipes must be so arranged that they will not interfere with putting in the permanent lining.

The result of my own study on the matter is to place the freezing pipes horizontal and parallel and in a circle near the periphery of the tunnel and somewhere from 3 to 6 ft. apart, as experience shall prove to be the best distance. The brick lining is kept along pretty close up to the excavation. Back at a convenient distance from the heading, in the finished portion of the tunnel, I would have a frame which can be readily moved forward at intervals. Against this frame will be worked the hydraulic jacks, which will be used to push the pipes forward. Occasional bricks can be temporarily left out of the lining to form offsets which can be used to hold the frame in place. Each of the large pipes would have a small pipe inside, extending nearly to the point where a diaphragm, provided with a great number of small holes, would form an obstruction to the circulation. Another small pipe would pass the entire length of the larger one and through this diaphragm.

The ice-machine may be located outside and the cold solution brought through a well-wrapped pipe to the heading. Flexible connection could be made with the system of pipes so that the cold circulation can be maintained throughout the entire length of the pipe, except from the forward point back to the diaphragm. There will be no tendency whatever for the circulation to penetrate beyond the diaphragm. The object of thus limiting the circulation is to prevent possible freezing ahead of the pipe. When the excavation has progressed so that any one of the pipes should be pushed forward, the circulation of cold fluid in it is temporarily suspended, and for a few moments warm brine is circulated throughout the entire length of the pipe, being permitted to flow in through the longer small pipe. The result would be the thawing of a film about the large pipe. While thus loosened the pressure would be put on the hydraulic jack in which the large pipe terminates at the inner end, and by this means the pipe forced forward, say 10 or 15 ft. The circulation of the cold solution would then be resumed. The frozen mass would form a guide for the pipes.

In the case of the proposed subways under Broadway, New York City, the availability of this means of preventing with absolute certainty any lateral movement of the material about the foundation of the buildings, ought to remove all fears of this danger in connection with that enterprise. Where necessary, in a case of this kind, a row of pipes could be sunk close to the curb line, and a frozen wall thus placed between the buildings and the street to be excavated.

This recalls another work of great importance that had to be done with extreme caution, which could have been accomplished with the greatest of security by the new method. I refer to the spreading of the foundations of the Washington Monument, at Washington. Since the monument has been completed there has been considerable said about a stratum of sand which is said to exist below the foundation, and which is feared may at some time be penetrated, and the weight of the monument squeeze it out laterally. If this danger really exists, how easy it would be to freeze a wall about the monument, excavate through this stratum, and put in a permanent barrier to its exit. The freezing process removes also the chief difficulty in the construction of subaqueous tunnels, by sinking them in sections from above, as has frequently been proposed. The chief difficulty in this latter method has always been to make the connection between the sections. To do so by freezing would be readily accomplished by providing the ends of the sections with a pipe running around them outside the tunnel space; then, when it is desired to make the joint between two sections, after filling the space between them with mud, this latter could be frozen, thus forming a barrier to the influx of water while the permanent joint would be made. Another application has occurred to me in studying the difficulties that may have to be overcome in building a railroad tunnel between Canada and the United States, under the St. Clair River, where my firm is now driving a small experimental tunnel. Under the deepest portion of the river there is scarcely enough material intervening between the rock and the bottom of the river to leave a safe thickness overhead while the excavation is made. It may be necessary to provide what I may call an immense turtle-back, which could be lowered on the bottom to serve as a temporary roof. To be effective it should be provided with low, sharp sides, and the entire under surface furnished with channels for the circulation of the cold fluid, so that when lowered on to the bottom of the river the thin roof that would have been dangerous could be converted into a frozen solid, which would perfectly protect the work underneath. Still another application occurs to me in connection with this work. The material at the center line of the proposed large tunnel is such that we anticipate no difficulty whatever in driving the 6 ft. heading which we are now commencing. Better than the turtle-back I have mentioned, it may be to use this trial tunnel as a means of freezing for a sufficient distance about it to permit the excavation of the large tunnel entirely in frozen material. To do this, a car with coils 100 or 200 ft. long, *i. e.*, the coil that length, not the pipe, in which the vehicle of cold could be circulated, could be introduced into the small tunnel and kept immediately in front of the excavation while this latter is made and the permanent lining put in. I believe that no difficulty would be found in freezing 15 or even 20 ft. radially out from this small tunnel by using means of ample capacity. Thus it will be seen that the construction of under-water tunnels, one of the most hazardous and expensive kinds of engineering, has a resource of incalculable value in this new method.

In the construction of deep and difficult bridge foundations, it is likely also to render great service.

Where a foundation is to be obtained on a bed-rock which is very unequal in elevation, and is overlaid by material hard to excavate on account of water, the freezing method is admirably adapted to cope with the difficulties encountered. Where such a pier is to be built in the water, a bottomless caisson or a coffer-dam would have to be first placed in position, and the freezing-pipes put down through or inside the same. Such a coffer-dam may be made with less than the usual care, and earth of some kind filled in around the pipes and frozen. Another

case in bridge construction, where the process could be most advantageously used, would be where it is desired to found a pier on bare rock, where the water is of considerable depth. An open caisson could be sunk on to the rock, being first provided around the bottom with a pipe through which a cold liquid could be circulated after the caisson was settled to place, and sand dumped in about the space between the caisson and bed-rock. When this would be frozen, it would perfectly shut off any entrance for the water, which could then be pumped out and the bed-rock laid bare. The supreme advantage, however, of the process in bridge work will be in obtaining foundations where a trustworthy resting-place is beyond the depth attainable by the pneumatic process, and there are many such places in this country, where bridges are or will be badly needed. It has one disadvantage in comparison with the pneumatic process, in any case where the two methods might otherwise be equally desirable; that is, the excavation has to be completed before any of the permanent work can be started. Whereas, in obtaining a foundation by pneumatic process, the caisson itself becomes a part of the pier, and the masonry is laid on the caisson, while the latter is undermined and sunk. In other words, the pneumatic method would require less time.

It has, however, the disadvantage that the caisson cannot always be sunk in the exact position desired, and the foundation is therefore generally superfluously large, adding in this way to the cost. By first excavating to the bed-rock, the foundation could be built in the precise location and of the exact dimensions desired.

Where a ship has been sunk by collision, making it difficult to close the break, so that she could be pumped out and raised, the opening, however irregular, might be readily closed by freezing.

To accomplish this, it would only be necessary to lower a coil of pipe into or about the opening, throwing something into the latter to impede the circulation of water, and then circulating the brine and freezing the opening fast. In salt water it would, of course, take a very low temperature to accomplish the freezing. It would not be difficult to make an ice machine to produce an excessively low temperature. Those now made for commercial purposes can produce a working temperature of at least 15° or 20° below zero, Fahrenheit.

An early application of the new process is likely to be made in sinking a shaft to a bed of sulphur, discovered several years ago in Louisiana. This occurs at a depth nearly 500 ft. below the surface, and to reach it, beds of sand have to be penetrated where the head of water in same is 300 ft. An effort was made to pass through this, but failed, after an expenditure of, I believe, some $200,000. To sink this shaft, the pipes would either have to be put down the entire length at the start, or else resort would have to be had to some method similar to those mentioned in connection with tunnels; or it might be better to build the upper portion of the shaft so large that near the ends of the first set of pipes put in, an offset could be made, through which a second set could be inserted.

I have now mentioned the peculiar fitness of the Poetsch method for certain classes of work. The chief difficulty in applying it, where there is any difficulty, will be to insert the pipes properly. This difficulty is likely most often to arise from the presence of boulders or logs in the material to be penetrated. It is true this can be overcome by drilling, but it would be very expensive. There has not yet been sufficient experience obtained to enable us to determine the best sizes of ground pipes and the maximum space we dare leave between them. Mr. Poetsch has continued to copy his first success, using 8-in. pipes placed about a meter apart. In some cases the pipes have not been sunk exactly as desired, leaving a space 5 or 6 ft. between them at the bottom; still, the frozen mass was continuous. The fact is that the freezing is due to the cooling of the entire mass in the vicinity of the pipes, and it would seem more a question of total quantity of cold inserted, and distance from the center ol application of this than the distance of the point from any individual pipe.

Another possible difficulty that will occur only in rare cases is the presence of considerable quantities of running water through the material to be frozen, which would thus be a vehicle to carry away the cold as fast as supplied. This difficulty is more likely to be encountered in sinking shafts to existing mines where pumping is in progress. As regards cost of doing work by this process, if we except the expense of the possible difficulties just mentioned, we may estimate beforehand the cost of a proposed work, with more accuracy than by any other method; and we may say the same with regard to the time required. This because of the certainty of removing the greatest contingency in such works, namely, that due to the influx of water or soft material. The enemy is converted to an ally and made to stand guard while the victory is won.

In underwater works accidents very often occur from the failure of machinery. Imagine, for instance, what would have happened to the great pier at Havre-de-Grace, had our pneumatic machinery failed, even for a few hours, while we were holding the pier, weighing millions of pounds, on a cushion of air. With a frozen wall several feet above us, we would have been in safety while any conceivable accident to the ice-machinery could be repaired, as it would have taken several days, or at least many hours, for dangerous thawing to occur. It has been customary in Europe, and will probably always be advisable, to keep the ice-machine running until the permanent work is put in place.

Difficulty might be anticipated in putting in a brick or masonry wall close to the frozen material. As a fact, no difficulty has been experienced in doing this.

The Old World was a more favorable field than the United States for the development of this process, because the coal fields have been more completely exhausted, and the time was ripe for the invention of a means of reaching the more inaccessible ones. Until three decades ago it was deemed practically impossible to bridge the Missouri or the lower Mississippi, or to obtain adequate foundations in many other places where the difficulties have since been successfully overcome by the pneumatic process. And just as this has rendered easy and of common occurrence the execution of works not long ago regarded as impossible, so this freezing method seems destined to make a step forward of no less importance.

Lake Shipbuilding.

(From the Chicago *Tribune*.)

THE outlook for the coming season's lake-carrying trade is so flattering that vesselmen have not only advanced their rates very considerably, but they have generally concluded that more ships can be profitably employed. They have, therefore, rushed their orders into the shipyards from Buffalo to Milwaukee, and shipbuilders are now as busy as bees, hurrying to complete as many vessels as possible in time to catch at least a portion of the coming season's traffic. The vessels which are now being built are not little schooners, such as were turned out in former days, but almost all of them are large steamships, averaging over 2,000 tons in carrying capacity. A number of them will have wooden hulls, but the largest and finest vessels will have steel hulls, while their appointments are generally of the most approved style of marine architecture. Great strides have been taken in this respect by the lake shipbuilders during the past few years, and their work will not suffer when compared with that of the seaboard builders.

The greatest activity in lake shipbuilding is at Cleveland, Ohio, where 16 vessels are in process of construction at the present time. Next in importance are Detroit and Bay City, Mich., at each of which places nine vessels are under way. At Buffalo, N. Y., three steamships are being built, and the same number at Trenton, Mich. At Milwaukee, Wis., two are under construction, while at a number of small shipyards at various locations on the lakes single ships are being built. The Cleveland vessels will cost from $120,000 to $265,000 apiece, and will each carry from 2,000 to 3,000 tons of freight. The Detroit vessels are of greater variety, ranging from 1,200-ton

barges to 2,650-ton steamships, and costing from $75,000 to $275,000. The Buffalo vessels are all large, from 2,000 to 2,800 tons, and will cost from $135,000 to $300,000. An estimate of the total number of lake vessels now being built, their carrying capacity and cost is as follows:

Port.	No.	Tons.	Cost.
Cleveland	16	36,500	$2,340,000
Buffalo	3	7,600	735,000
Detroit	9	16,200	1,301,000
Bay City	9	18,600	1,060,000
Trenton	3	5,800	315,000
Marine City	1	2,300	120,000
St. Clair	1	2,400	130,000
Milwaukee	2	4,500	270,000
Grand Haven	1	2,500	130,000
Mt. Clemens	1	200	4,000
Baraga	1	1,600	35,000
Total	47	98,200	$6,440,000

In looking over this table it is worthy of remark that Chicago is not found in it. The City of Chicago has vast commercial interests, second to no other city located on the lakes, and its merchants and business men are heavily interested in shipping, owning an important part of the new vessels being built elsewhere; but it has no shipyard. In this respect Cleveland, Detroit and Buffalo, to say nothing of still smaller cities, cast it completely in the shade. This is all the more remarkable, as Chicago business men are alert and progressive, having distinguished themselves in every branch of the iron and steel trades into which they have embarked. If a modern iron and steel shipyard can be sustained at Buffalo, there would certainly seem to be hope for one to succeed at Chicago.

Indian State Railroads.

AT the close of their last fiscal year the state or government railroads of India included 5,350 miles in operation, and there were in addition 2,265 miles under construction, and 435 miles under survey. These lines were divided as follows:

	In Operation.	Under Construction.	Under Survey.
Imperial lines	3,010	1,204	67
Provincial lines	1,554	286	54
Imperial lines worked by companies	316	715	289
Native State lines	470	60	25
Total	5,350	2,265	435

The *Indian Engineer* says: "The rate of progress in opening up new lines is, to say the least, disappointing. During the official year ending March 31 last, only 264½ additional miles were added to the State railway system, and for the six months from April 1 to September 30 last, the new length opened amounted to only 72 miles. It is not to be wondered at that with so miserable a speed of development the 'indirect' charges and the ordinary establishment expenses debitable to capital should attain such extravagant proportions. But such has been done of late toward economizing these charges, and the lines now being opened up by the State, and the assisted companies, will, it is believed, show greatly reduced figures for these accounts. The over-cautious system followed by the Government of India, requiring the strictest scrutiny into small and unimportant details, and the withholding of sanction to the whole undertaking until some trifling local question was finally arranged, has had much to do with the tardy rate of progress that has characterized the development of railways in this country from the beginning of operations down to the present time. It is generally admitted that the staff forming the Indian Executive is as efficient as any similar body of officials in any other part of the world; but no liberty of action is allowed, and therefore there is a small chance for the officers to distinguish themselves.

"Excluding the East Indian, and omitting the Imperial lines worked by companies or owned by native States, the Government of India possessed on December 31 last 4,564 miles of railway open to traffic, and 1,490½ under construction, besides 121 miles under survey. * * *

There is a marked reduction in the expenditure on construction and equipment on the lines lately brought under traffic, and there is reason to hope that the days of obstruction and petty interference from supreme headquarters are henceforth to be numbered among the things of the past. Of the 2,265½ miles under construction 643¾ are classed as 'Political,' being a part of the Sind-Pishin and Sind-Sagar extensions, including 57 miles of the temporary Bolan line. The Indian-Midland had 311¾ miles; the Southern-Mahratta, 403½; the Nagpur-Bengal, 287½; the Assam-Behar, 124¼; the Lucknow-Sitapur-Kheri, 124; and the Bellary-Kistna and Cuddahpah-Nellore 208 miles of works in hand at the end of the year. The portions under survey were confined mostly to 289 miles of the Indian-Midland, 54 of the Assam-Behar, and 45 miles of the Nagpur-Bengal; but since the close of the report under review, December 31 last, many other important surveys have been decided upon, a part of which, together with the preliminary estimates, etc., are either completed or in a forward state. In the proposed extensions we are glad to find that Madras is to receive its fair share, for 631 miles—414 'Imperial' and 217 'Local'—have been under survey during the current year, and actual work is expected to commence on several sections during 1887."

Photographic Map Reduction.

[Paper read before the Engineers' Club of Philadelphia, by O. B. Harden.]

THE reduction of maps and plans, forming as it has a large part of the work of the drawing office of the Geological Survey, has led to the constant use of the camera in reducing and duplicating the maps which have been placed at its disposal; and believing that its general use would be to the interest of engineers I desire to call the attention of the club to this method of reduction.

The first use of the camera by the survey for this purpose was in 1883, when it was desired to have a quicker and cheaper method of reducing the large mine maps of the coal-operating companies to the working scale of the survey, a reduction of from 100 ft. to 600 ft. to 1 in. It was found to be so large a saving of time and labor (having up to this time used the pantagraph) that all the maps since that time, of any magnitude, have been so reduced.

Having made use of the existing information in the special areas in which work has been prosecuted, it has been frequently necessary to have maps reduced and duplicated in the shortest possible time, in order that the original maps might not be long away from the offices in which they were frequently used. This is especially true of railroad maps. The time necessary to do this became a matter of importance, and as the most accurate, quickest and cheapest means of reduction, they have been reduced by the camera.

The maps have been of a variety of scales, from 100 ft. to 1 in., to 6 miles to 1 in., and have been reduced as small as 10 miles to 1 in. It has not been found that the size of the reductions affected in any way their accuracy. It may be remarked that, however small, there is that fidelity in detail that is only equalled by the photographic lens. To those who are accustomed only to the more common methods of reduction and the fallibility of the ordinary draughtsman, this fidelity to detail is gratifying. Even by the use of the pantagraph and rectilinear lines, the reduction may be accurate in length and breadth and yet be perceptibly wrong within a square, dependent upon the care of the draughtsman.

In many cases the mine maps reduced, being in the conventional color of the bed, have not photographed well, especially so in the case of ultramarine and purple shades, which have to be strengthened on the print in order to be observed through the tracing cloth. This is so with the specimen prints of the workings of the Pennsylvania Coal Company.

The beautiful regularity of the mine workings shown in these reductions is a marked feature.

The originals of the alignment of the Pottsville & Mahanoy Railroad were drawn in colors, black, chrome-orange, purple, red and green, and as shown on the prints it has been necessary in the case of the red and purple lines to strengthen them. I desire to call special attention to these prints as being typical of the work of Messrs. Julius Bien & Co., of New York, who do this work for

the Survey. The green color having been made up of yellow and blue, the yellow on the original has separated and produced a heavy blurred line. The contour lines are drawn in chrome-orange. The lines drawn in black appear the most distinct, hence it is preferable that maps should be in black to photograph well.

The scale of these prints is 1 mile to 1 in., reduced from 1,000 ft. to 1 in. It is necessary in joining them together that it be quickly done and as little paste used as possible, as the paper is very sensitive. It is more expeditiously done by overlapping the prints and pricking holes through two common points on each, mark out and cut off the one print to overlap the other half an inch, paste the lower print and stick the pins back into the same holes; the two prints are then coincident.

There is practically no limit to the size of map which may be photographed, as it is only exposed to the camera in sections of about five feet square, when the negative required be as large as 21 × 25 in., this being the largest size taken by Bien & Co.

The maps are reduced to their proper size by the operator tacking a strip of paper with the original scale upon it above the section of map to be reduced, another strip being cut the reduced size and held up to the ground glass of the camera until it is so focused as to be the required scale.

The only element of error entering into the reduction of maps by the camera, aside from the care and skill of the operator, is the expansion and contraction of the sensitive paper. It should, however, come back to its original size after immersion; if it is found not to do so, an allowance is made by making the scale larger or smaller as the case may require. The accuracy of the reduction depends as much upon the perfect adjustment of the map at right-angles to the line of sight as to the scaling by the operator.

It is unnecessary more than to mention that there is no error due to distortion, this being compensated for by the combined lenses used for such work.

The largest maps reduced for the Survey are the splendid topographical maps of the Philadelphia Water Department, being the results of its surveys for a future water supply for Philadelphia.

These maps cover an area of 446 square miles in Montgomery and Bucks Counties, and have been reduced from 400 ft. to 1 in., to 1,600 ft. to 1 in. The area of original map-surface is about 773 square feet. The area of map-surface of the prints when put together is about 193 square feet. The reduction of this immense surface has been made in 30 negatives. The maps are made in colors, the roads yellow, the timbered areas green, the buildings in red and the streams in blue.

In order to prevent any errors resulting from the shrinkage or imperfect joinage of the prints, a templet will be constructed for the final map with the lines of latitude and longitude on a polyconical projection drawn upon them, these lines being on the original map.

A comparison of the cost shows that there is a saving of about 40 per cent. over the other methods of reduction. This is where a reduction alone is required and where the map will answer its purpose upon the sensitive paper; where, however, the map is required upon tracing cloth, or where it has to be transferred to a more substantial paper, the saving is about 30 per cent.

Steam Ferries vs. Large Bridges.

[Major W. Sedgwick, R. E., in the *Indian Engineer*.]

THERE seems to be at present upon our railroads in this country a rage for building large bridges, and an innate antipathy to everything in the shape of river navigation.

From the last Administration Report of the Railroads in India, it appears that in 1885–86 there were at least nine large railroad bridges under construction in Upper India alone.

Now we may perhaps assume with safety that the construction of these nine large bridges with their approaches and protective works will involve an expenditure sufficient to have built and equipped 500 or 600 miles or more of broad-gauge railroad with a surface track; and five or six times as great as the amount which would have been required if steam ferries had been used instead of bridges.

The worst of it is that, in view of such heavy expenditure, people will be apt to imagine that we must be making great progress in railroad construction; although in reality the expenditure on large bridges is being incurred mainly in substituting one method of crossing large rivers for another, much more troublesome indeed, but at the same time less costly by far.

It is not of course possible for a moment to doubt the vastness of the importance of large bridges in a wealthy country, nor the grandeur of the service rendered to the world at large by those who, as at the two Hooghly bridges, have shown us improved ways of constructing large bridges; neither can it, of course, for a moment be doubted, that if funds in plenty were available for railway work it would be well to build large bridges freely in India. But as large bridges are very costly and money is scarce, and the want of funds prevents the construction of a multitude of lines which are indispensable for the development of the country, it may be worth while to consider whether India could not for the present get on very well without large bridges. The necessity of looking into the matter at this particular time arises from the fact that the successful completion of bridges, such as the Hooghly and the Sukkur bridges, will certainly bring into the field many other projects of a similar kind, but doubtless, in some cases, on a more extensive scale.

If we do not bridge our large rivers, we must, of course, put steam ferries upon them. It may be worth while, therefore, to look into the working of some of the existing steam ferries with a view to ascertaining their capabilities, and whether there is any real reason why we should not be contented to use them on our large rivers in the present condition of India, in place of building expensive bridges.

We find then, from the Administration Report before referred to, that the Indus Valley State Railroad has practically demonstrated the possibility of sending loaded railroad carriages or wagons or even locomotives bodily across the largest rivers by steam ferries, to any extent which can possibly be required, by actually sending no less than 93,483 broad-gauge wagons and 50 locomotives across the Indus at Sukkur in 1885, or an average of over 250 broad-gauge wagons per day; and thus have shown, also, that it is quite unnecessary to put, as is now ordinarily done, passengers to the inconvenience of turning out of their carriages at a ferry perhaps early in the morning or late at night when they have comfortably settled themselves for a long journey; and add thus to the many annoyances which have to be endured in railway traveling in India; and also that it is quite unnecessary to put the staff of the railroad to the trouble of unloading wagons into flats at a ferry, and then the flats again into wagons, and getting consignments sorted after they have been mixed up upon the flats; since carriages and wagons alike can be sent bodily across by the ferry with their loads. The North Bengal State Railroad has shown, at the ferry over the Ganges at Sara, that the detention at a ferry, even in the case of the largest and most troublesome rivers, need not be greater than the ordinary detention at a large junction between railways owned by two different companies; and has shown also that by arranging to give passengers one of their meals upon the ferry steamer the detentions at a ferry can be utilised, and a long stoppage at some other point upon the road thus avoided. The North Bengal State Railroad has further shown that a steam ferry can be worked by night as easily as by day, if the river channel is regularly surveyed and marked out by colored lights; and has thus done good service not only to steam ferries, but also to the cause of Indian Inland Navigation by making it clear, that if we will go to a comparatively little expense annually in surveying, improving, and lighting the channels of our great rivers, steamers will be able to run over them by night as well as by day; and our magnificent Indian waterways will then take their proper place as subsidiary lines of communication of the cheapest

and most useful description, instead of being neglected and despised.

We do not find, however, that any railway has as yet made a serious attempt to diminish the difficulty of working a ferry on a river with a wide and shifting channel; but it would appear that, so far, railways have been contented to go on putting down ghât stations and taking them up again each time the river shifts its channel, perhaps even twice in a year. And yet there seems no reason to doubt that it would be quite possible to have permanent ferry stations, even at the most troublesome rivers, by simply arranging to lead the river to some permanent site upon the railroad by steamer canal, instead of leading, as is now done, the railroad to the shifting river's edge by a ghât line and station. In the construction of steamer canals it would often be possible to utilize the channels of nullahs or khalls; or failing these, the river itself, when in flood, could, if the flow were directed by a suitable arrangement of mat bunds through a small cut so as to enlarge the cut by the scour, be made to do much of the necessary excavation.

If the river cuts in after a steamer canal has been constructed, the length of the canal will simply be shortened and the canal thereby improved; and, if the river goes off, the canal can easily be extended so as to meet it again; and no other alteration beyond some dredging annually will be necessary. But in the case of a ghât station the whole station has to be reconstructed at great trouble and expense every time the river changes its course, whether it cuts in or whether it goes off.

In any case it would seem clear that the present defects in steam ferries can be got rid of to a great extent by adopting improved methods of working.

But having looked thus at the defects of steam ferries, we may now glance at their advantages, and it is *quite* clear that they offer in some respects decided advantages; for we find, in the first place, that in the matter of cost the capital outlay on a steam ferry is small in comparison with that on a large bridge. Thus we find that a steam ferry across the Ganges on a scale sufficient to take the traffic of a railroad such as the North Bengal or the Tirhoot State Railroad does not cost more than $180,000 to $215,000, though the channel crossed at Sara or Mokameh is two miles or more in width, and the capital cost of a bridge would certainly be 10 or 12 times as much. And then the cost of working a steam ferry can be entirely recouped by levying a special charge for the ferry, while no extra charge can be levied on account of a railroad bridge; although the annual charges for interest on capital expenditure upon a large bridge, with its protective works and approaches, will alone, if loss by exchange is allowed for, cover the entire working expenses of a steam ferry, as is very plainly shown by the Administration Report of the Railroads in India. From these reports it appears that the Sukkur ferry over the Indus was worked in 1885 by the Indus Valley State Railroad at a cost of $74,867, and that the cost has a tendency to fall rather than to rise; for we find that in 1881 when 31,976 wagons were sent across by the ferry the cost was $61,259, and in 1883 when 62,353 wagons were sent across, $76,599; while in 1885 when 93,483 wagons were sent across the cost was only $74,867. It appears also that the cost of working the steam ferry on the Tirhoot State Railway over the Ganges at Mokameh fell from $45,555 in 1884 to $40,088 in 1885.

But if a ferry such as that over the Indus, at Sukkur, with 250 broad-gauge wagons, on an average, to be sent across daily, can be worked at an annual cost of $74,867; and the traffic of the Tirhoot State Railway in 1885 across a river two miles in width, such as the Ganges at Mokameh, at a cost of $40,088, it seems plain that the annual charges for interest on capital outlay on a large bridge, with its approaches and protective works, would in any case fully cover the working expenses if the large bridge were replaced by a steam ferry; while in addition to charges on account of interest, there are maintenance charges and charges for depreciation on account of the gradual deterioration of the superstructure and for flood damages to be allowed for in the case of the large bridge.

The steam ferry has a further advantage over a bridge as a means of crossing large rivers by giving much greater freedom in the choice of an alignment for the railway, and in requiring no delay during construction and also in admitting of easy removal, if it should be necessary, for any reason to shift the site of the crossing.

Hence it would seem that both from a financial and from an economical point of view the steam ferry has, along with its defects, decided advantages over the the bridge in the case of large rivers.

Whatever, then, rich countries may do, it would seem that, in a poor and undeveloped country, such as India at present is, we should do well to keep to steam ferries at large river crossings, though insisting indeed on improved methods of working being adopted at our ferries so as to do away, at least, with the necessity for turning passengers out of their carriages, or breaking bulk in the case of goods traffic; and should do well to discourage all projects for large bridges except in special cases.

In regard to the military side of the question, we must danot forget that large bridges in India are liable to be maged not only in the ordinary course by railroad accicidents and by floods, but also in times of disturbance by dynamite, and by derailments of rolling stock designedly brought about. And it is beyond question that the native staff, by which, to a large extent, all our railroads are now worked, will form a weak point in our communications in times of disturbance, which will increase greatly the difculty of guarding our large bridges in these days when destructive appliances have been brought to such a state of perfection that a native, whose dark skin and stealthy approach will be perfectly invisible at night even to the most vigilant of sentries, will be able to carry and affix charges sufficient to damage hopelessly the superstructure of a large bridge.

Besides, in the case of large spans, it may be well to remember that we have at present no means of forming an opinion in regard to the durability of the superstructure, which may possibly fail much sooner than we imagine under the effect of vibration transmitted through long distances, and therefore, in all probability, through some weak places; transmitted, too, in the case of cantilever bridges, through more or less open joints at the centilevers, and therefore, to some extent, by blows.

The Electric Lighting of Trains.

(From the *Electrical Review*.)

MESSRS. R. E. CROMPTON and J. SWINBURNE have recently patented some improvements in the electric lighting of trains, which appear likely to be of considerable value. One of the difficulties in train lighting is that if the dynamo is driven from the axle it does not go at a uniform speed. To get over this difficulty, the inventors adopt the following arrangement: The dynamo is driven off a countershaft, which is driven off the axle of a carriage or van. The countershaft is in the same horizontal plane as the axle, so that the movement of the carriage, relatively to the wheels, does not affect the dynamo. The dynamo is in connection with secondary cells. The field magnets are wound with two wires: one is in shunt to the armature as if the dynamo were an ordinary shunt machine wound to work at a low speed, say 500 revolutions. The lamps are in shunt to the armature also; but the cells are so connected up with the second wire that if the dynamo charges them the current goes round the field magnets by the second wire, so as to demagnetise them. Thus the dynamo is like a compound machine wound to work with a low speed, and having more main than usual, and that main coupled up backward, the lamps being in shunt to the armature only, and the cells in series with the backward-wound main. The result is that as the speed increases above 500 the dynamo charges the cells, but the pressure on the lamps does not rise much, as the field is demagnetised by the current going to the cells. The second wire is so arranged that at the maximum speed the cells take their maximum charging current, which demagnetises the fields to the right degree. If the speed falls below 500, the cells begin to help the dynamo by supplying part of the current to the lamps, and in so doing they magnetise the field more strongly, so that the

dynamo does not stop giving current till it goes at, say, 300. The second wire or backward main is made thick, so that there is little loss of pressure even with a large current to the cells.

As the train sometimes stops and sometimes goes backward, means must be taken to prevent the current from the cells from burning the armature up when stopped. The inventors state that the method they find to answer well in practice is to have a cut-out in circuit to break the armature connections when the speed falls below a certain value. The dynamo is driven in the usual way, so that when the train stops or reverses the dynamo does so too. In this case the brushes must be shifted on reversal. To effect this the brush carrier or cross-bar is mounted on the axle so as to turn with it, but is held by adjustable stops, so that if the machine goes one way the brushes go round until the stop holds them in the right position for that direction of rotation, and if the train goes the other way the brushes are carried about half a revolution until they come to the other stop. Tangent brushes, or brushes that will allow the commutator to run either way under them, are used.

A centrifugal or other suitable governor works a cut-out which cuts out the armature when the speed is too low, and puts it in again when high enough. This governor may also cause the short-circuiting of the backward main when the armature circuit is broken. It may be mounted on the dynamo shaft.

Instead of a speed cut-out an electric arrangement may be used which is actuated by the armature electromotive force in making circuit, and by the discharge of the cells in breaking it. There are many ways of doing this by double-wound electro-magnets; and the field magnets may be made to polarise the cut-out.

Electric Motors.

[Abstract of address delivered before the National Electric Light Association at the Philadelphia meeting, by Mr. J. F. Sprague: reported by the *Electrician and Electrical Engineer*.]

THE time has come for us to look upon the distribution of power in a light altogether different from that in which it was viewed three years, or even one year, ago. We have heard about electric motors, and we have talked about the possibilities of the transmission of power ever since Pacinotti ran his first motor. But motors were run primarily with batteries, and it is only recently that they have been operated in connection with central stations.

They have been made of small sizes and treated as toys, and more batteries and motors have been invented than there have been made variations in the steam engine, but we have never reached any position from which we could show a commercial return from the use of electric motors until the last year or two.

The distribution of power by electricity, so long looked upon as a visionary and to-be-hoped-for attainment, is now an accomplished fact. It is in its infancy, but it has a future probably second to no other enterprise in the commercial world. It is not necessary here to give a sicientific explanation of the operation of a motor.

The practical questions which arise are: Who are to exploit this business? Who are to be actively interested in the extension of this system for the transmission of power?

There are two representative industries already in the field. The first to come was the arc light; then the incandescent light; and now, finally, comes the transmission of power for industrial purposes. There have, in consequence of the order of development of these three different methods of using electricity generated at a central station, arisen three different interests, more or less antagonistic to each other, but which ought to be working in harmony.

As being in the position to actively take up this work, I may mention, first, arc-light companies.

A very large number of existing companies have already secured franchises which it would be difficult for other companies to obtain. Some of these companies are to-day just barely meeting their running expenses, because they are supplying power for lights for only a fraction of the day or night in close competition with the gas interests, and perhaps with other electric light companies. As the demand for light varies, of course, at different times of the year, the receipts vary above and below the operating expenses. All through the day, till perhaps five in the afternoon, these stations lie idle. Such companies have their poles erected, their lines run, and certain franchises in their possession, and it would be an easy matter for these same companies to run lines for the distribution of power on the same poles as carry their arc-light circuits. The wiring for this purpose would be very simple. In some cases the poles would have be to re-enforced; in others it would not be so. For running these lines to supply power alone, constant potentials as high as 400 volts could be used with perfect safety, and this would very much reduce the size of the wire.

As regards incandescent light stations, many of these run only in the daytime, and do not begin their lighting until late in the afternoon. The bulk of their lighting terminates long before midnight. Other of these stations run during the day because they find the necessity of supplying a few lights in the daytime to get certain contracts for night-work, but almost invariably this day-work is at a loss. These companies already have their lines run to supply power on constant potential circuits, some overhead and others underground. Since the power would begin in the morning and continue for a general average till the latter part of the afternoon, and then begin to fall off, and the light at the same time begin to come on, such a station, if worked up to its full capacity, ought to have an almost continuous load from morning until late at night; the load consisting first almost entirely of power, then of light and power combined, and finally almost entirely of light.

The gas-engine, although it has made great strides in England, does not stand in high favor to-day in the United States. A gas-engine will not work up to the capacity at which it is sold and at which it is nominally rated. It will fall off anywhere from 25 to 50 per cent. below this. Its motion is necessarily irregular and uncertain, because during a large part of its rotation it is dependent upon the inertia of the fly-wheel. Such machines are necessarily more costly than electric motors of the same capacity, such cost being about double. They are noisy, they cause a great deal of heat, and they are uncertain. Their advance in England was made before electric motors were as practical as they are to-day, and where gas is sold at a very much lower rate than it will be possible to get it for in the United States for many years to come. The electric motor, then, can easily compete against the gas-engine when put side by side, both in initial cost and expense of operation. It is likewise more compact and has an excess capacity, a quality that is never claimed for a gas-engine. Gas-works have among their residual products coke, which is of very little value. By putting in good generators, running wires for the supply of power alone, and putting the generators and dynamos in charge of the men who are already employed at the gas-works, they could produce their power and sell it at a very advantageous price. Their office rent, officials' salaries and attendance would be reduced to a minimum.

Special stations should be put in good manufacturing and industrial districts, and preparations made to supply any demand for power from a half H. P. up to 100 or more H. P. There is no possible question that, when a large number of motors are supplied from one district, even when dealing with large powers, electricity can successfully compete against steam.

Double circuits can be used, small powers being supplied at 100 volts, and large ones at 400. Such stations should be built to get the steam power at the lowest cost, and hence should have the best engine and the best method of fuel consumption. The district covered will depend upon the location of the station. If this is central, wo or four square miles can be easily covered.

I will now consider the different classes of circuits on which motors may be used.

1. Arc-light, or constant current circuits, in which the

current supplied to the motor is kept constant at a certain number of amperes, ranging from 6 to 19 amperes in different systems. The electromotive force at the terminals of the motor varies with the load.

2. Constant potential, or incandescent light, circuits, in which the difference of potential at the terminals of the machines is kept practically constant while the current varies with the load.

3. Circuits in which the current and the potential both vary, as is the case where there is an appreciable drop or fall of potential on connecting lines somewhat removed from the source of power of a constant potential system.

I am now operating on all classes of these circuits, but since, because of the small ampere capacity of the current on arc-light circuits, any large power must require a great difference of potential at the motor terminals, and variations of power will cause sudden and great changes of potential, the arc-light circuits have principally been used in conjunction with arc lights for transmission of small powers only, or for constant work.

In considering the transmission of power as an industry, that is, in a broad and comprehensive way, and not as an adjunct to some system of lighting, I may here state that practical and theoretical considerations make it imperative that the constant potential method of distribution is the only safe and feasible one. Since I make this statement, it is incumbent upon me to explain the reasons. The only existing constant current circuits are used primarily for the operation of arc-lights. At present, as I have said, these range in capacity from 19 to 6 amperes. The unit of light which is required for general purposes necessitates an expenditure of about half a horse-power of electrical energy. A greater expenditure would be extravagant. In order to keep the size of the conductors as small as possible and to allow long extended circuits, the tendency is to reduce the amperes to the smallest number.

The conditions of an arc-light probably will not allow this to go below about 6 amperes; the more ordinary unit is about 9½. The commercial conditions unquestionably will not permit, in the future, of a much higher ampere capacity, because the size of the wire varies as the square of the current used. Now, with a 9½-ampere current, a motor to develop one H. P.—supposing it to have an efficiency of 80 per cent.—must have supplied to its terminals 933 watts of electrical energy. In other words, there would be at the terminals of the machine an electromotive force of about 98 volts for each horse-power developed. Suppose, now, we want to transmit 100 H. P.; it would then be necessary (if the motor be of the same efficiency) to supply to the motor 93.250 watts of electrical energy; and, if it were on this 9½-ampere circuit, we would have an electromotive force of over 9,800 volts.

Now, in practice, arc light circuits vary from, say, 1,000 to 2,500 volts. On a 1,000 volt circuit you could recover about 10 H. P; on a 2,500-volt circuit about 25 H. P. In other words, existing arc-light machines, if devoted entirely to the transmission of power, are limited to the actual development, on even the largest machines in ordinary use, of 25 H. P.; and, if used in combination with light, there would not be available on any particular circuit over a small fraction of this. Now if you are going to consider motors as toys, if you are going to deal with the transmission of the tenth of a horse-power or one-half H. P. or a 1 H. P. unit, and are willing to have the element of danger as well enter into these small transmissions, then you can work with an arc-light circuit; but if you are going to transmit units of 5, 10, 15, 20, or 25 H. P., you cannot deal with the arc-light circuit; it is utterly impossible.

In Boston we have recently put upon certain lines nearly 200 H. P. Suppose this were supplied on 9½-ampere circuits. No less than 8 circuits of 2,500 volts each would be required, and probably more, because with units as high as 15 H. P. and this division of circuits, the law of general average could come into play in but a very limited way.

These eight 2,500-volt circuits represent the capacity of a 460-arc lamp station, and to deliver the power not a single lamp could be used at the same time. Does any one really suppose that by this method of working, leaving out for the present all questions of danger and unreliability, the same results could be obtained as are in fact to-day? The constant current method of distributing power is the limited and unnatural method; the constant potential, the comprehensive and natural method. This is a fact entirely independent of the question of relative electrical potentials, because on the constant potential circuit we can work at 100, 500, 1,000 or 2,000 volts if we please.

In Boston we at present transmit up to 4,800 ft. on a 200-volt circuit.

When dealing with the question of power alone, and with an area of say four square miles, the station being near the center, I would prefer to work with 400 volts. Remember, then, that power transmitted means the transference of a given number of watts of energy. It is expressed by two products, quantity and pressure. If one is increased, the other may be reduced. If small conductors are to be used, then it is essential that small currents shall be used, and of necessity high electromotive forces, even when operating on a constant potential circuit.

When dealing with short distances and small powers, it is better to use low potentials; but, when dealing with large powers and long distances, it is absolutely necessary to use high potentials, because the commercial conditions will allow only a certain proportionate investment in copper.

Electrical Progress in Japan.

[Paper read before the National Electric Light Association at the Philadelphia Convention, by Prof. Fujioka.]

As my present visit to this country, with Mr. Yashima, President of the Tokio Electric Light Company, Japan, is to investigate the different systems of electric lighting and electric transmission of power, which are now in actual use here, so that we might introduce to our country the best and most reliable system, and not to make advertisements of our work, if any, I am not well prepared to give you any clear sketch of the progress of electrical engineering in our country, and I think this short paper which I have the honor to read now before such a remarkable body of electrical men as the National Electric Light Association, would be nothing but curiosity to you.

To begin with the electric telegraph, the first line was put up in 1869, if I remember right, with Breguet's A B C instrument. Since then many improvements have been, of course, introduced, and now nearly all the towns, small or large, are electrically connected, so that we can telegraph from any part of our country to any part of this country, or anywhere else, only it is rather expensive, *i. e.*, about $2.80 per word, from New York to Tokio. The instruments we use at present are mostly Siemens-Morse ink writers; and the wires are all overhead, except some wide rivers and straits, where, of course, subterranean cables are used. The Japanese telegraphs are completely under Government control.

It was in 1872 that the Imperial Engineering College was instituted in Tokio, and Prof. W. E. Ayrton, the well-known electrician, now in London, occupied the chair of the Professor of Telegraph Engineering and Natural Philosophy, and stayed there for six years, working in the line of electrical researches with Prof. John Perry, then Professor of Mechanical Engineering in the same college. These two gentlemen's names are pretty familiar to you, I guess, from their valuable labors in relation to the electrical engineering and the ammeters and voltmeters of their invention. Mr. Thomas Gray, assistant to Sir W. Thomson now, was with us in the college for about three years, and I have been connected with the college for a number of years, attempting to keep up with the progress of electrical applications abroad. I was here in 1884, when the International Electrical Exhibition was held in this city.

The telephone business is yet quite poor in our country, only the Government offices and residences of high authorities being connected. Petitions for permission of organizing telephone companies of exchange system are

made from time to time, but the Government does not permit it for some reasons or other, which I cannot tell. I believe, however, it will be permitted sooner or later.

Now, as regards electric lighting, we have the Brush arc lights in some factories, mills and dock-yards, and the Edison incandescent lights in some places, and among others may be mentioned 500 lamps in the Osaka Cotton Mill, and 330 in the Imperial Military College.

On many occasions, such as at the ball of the Minister of Foreign Affairs Department, on his Majesty, the Emperor's Birthday, *i. e.*, November 3, at the opening ceremony of the Banker's Meeting Place, and the like, we put up temporary plants with good success, and the result of this, together with the most satisfactory reports on the Edison incandescent lighting in the Osaka Cotton Mill and the *Official Gazette* printing office, induced our people to favor the electric lighting with great eagerness. The Tokio Electric Light Company, which was organized some time ago, and of which Mr. S. Yashima (now in this room) is the President, has a capital of $200,000, and by the end of this year this capital will be doubled. The company has in hand the contract of lighting the new Imperial palace with 2,000 incandescent lamps and 100 arc lights from the company's central station, located just outside the palace ground, and from which the current will also be supplied to the residences of the princess and ministers and other houses around it. It is proposed to place five or more central stations in the City of Tokio, two in Osaka, one in Kyoto, two in Nagoya, and other places. Considering from the fact that the City of Tokio is 10 miles square, with a population of 1,000,000, and that there is now only one gas company, charging $2.50 per 1,000 cubic feet of gas, and having old-fashioned gas furnaces, the Tokio Electric Light Company has a great deal to do toward the illumination of the city.

In conclusion, as there are many printing offices and small factories all over the city, using at present numerous men or steam engines, ranging from one-half to 20-horse-power, the electro-motors will also, without doubt, find good places there. I hope, gentlemen, I will be able to read a better paper when I see you next time.

The French Railroad Jubilee.

THE great railroad companies of France, acting together have made public the following statement:

"It is well known that a committee is making arrangements to celebrate in 1887 by a special exposition at Vincennes, a congress and fêtes, the semi-centennial of French railroads. This committee having made a new attempt to obtain the coöperation of the six great French railroad companies, those companies have felt obliged to decline the proposition, which was made to them in the most courteous manner, and to persist in their resolution not to associate themselves with this work. They are unanimous in regarding it as contrary both to historic truth and to the interests of the exposition now in preparation for the centenary of 1789.

"In the first place, as they have heretofore remarked, the beginning of the construction of railroads in France dates back to a period prior to 1837, and to celebrate a semi-centennial in 1887 would be to give the impression, contrary to the reality, that France had been notably left behind by other nations.

"In the second place, to organize a special exposition of railroads and the different industries attached to them only two years before the great industrial celebration of 1889, would be, the companies think, to deprive that celebration of a part of its attraction and its success; the six companies therefore believe that they ought to reserve all their efforts for the national celebration of the centennial.

"Finally, the companies recall the fact that a congress similar to that proposed by the semi-centennial committee was established by the International Association of Brussels, which was formed in 1885, and which has continued to act since then by the regular meeting of delegates from the different governments interested, and from the French and foreign railroad managements. The International Association has decided that the railroad congress shall sit at Milan in 1887, and at Paris in 1889. The companies do not see how this meeting can be reconciled, so far as they are concerned, with the programme of the committee.

"Under these conditions the six companies have all, without exception, repeated their refusal to join in the work of the semi-centennial committee."

Water Waste in Cities.

MR. PETER MILNE, ex-Water Purveyor of Brooklyn, recently delivered a very interesting and instructive address to the members of the Oxford Club of that city regarding the water-supply of Brooklyn. He was entirely right in maintaining that the embarrassment of a short supply which constantly meets all growing communities can never be adequately overcome until there is a radical change over the present methods of locating and fitting up water-supply pipes within buildings. The enormous waste which is due to the running of water from open faucets in cold latitudes six months out of the year, because the pipes and fixtures are located where the water is certain to freeze, and the leaking of improperly constructed apparatus twelve months out of the year, is due to the fact that there is no intelligent control of the character of the fittings used and to the way they are fitted up.

As Mr. Milne points out, it might not be practicable to attempt too much interference by municipal authorities in cities like Brooklyn with the details within occupied houses. In such an event the meter is the only resource, for that would in time deter the householder from recklessly wasting water which he knows he will have to pay for. But in all large cities this is hardly enough, since this will only operate to make a householder take care of the apparatus that he may have in use. The root of the matter is the location of plumbing in buildings, which should be controlled by the authorities when new work is being constructed. That is to say, plans should be filed, as required in the case of drainage, and when, in the judgment of competent persons, the location of pipes and fixtures is such as to insure their freezing in the winter months, such plans should be rejected and the plan modified to secure the needed protection. In other words, such care should be taken in the matter as is now exercised by the Health Department of New York and Brooklyn over the running of drain and waste pipes. Until that is done, even though meters are universally used, the householder, often through ignorance and frequently through causes beyond his control, will be compelled to pay for the water he wastes, which waste he would not be obliged to permit if the water-pipes in his building were in the first place properly located with reference to the possibility of freezing. In large cities the occupants of houses in the great majority of cases are only tenants, and, besides not being responsible for the location of pipes and fixtures in the buildings they occupy, would often find it cheaper to pay for water wasted than to incur the expense of remodeling the water-supply system of the buildings they occupy.—*Sanitary Engineer.*

The Berlin City Elevated Railroad.

WHILE there are sections of elevated road or viaduct in the railroad entrances into London and other large European cities, Berlin is the only one which has at present an elevated railroad used for city travel, although the building of an elevated line in Paris is soon to be begun.

The different railroads entering Berlin were united in 1875 by the Ringbahn, or Circuit Railroad, which forms an irregular circle, or rather oval, around the city. This was built by the Government for the purpose of connecting the roads, but it is also used for purposes of suburban traffic, as it passes through a number of villages and small towns.

To supplement this circuit road the Government decided to build a line running directly through the city,

connecting at each end with the Ringbahn, and through it with the various lines running out of the city. This road, which is known as the Stadtbahn, or City Railroad, was completed in 1882; it extends from the station of the Silesian Railroad on the east to that of the Charlottenburg Railroad at the west end of the city, following very nearly the course of the River Spree. At one point, indeed, it is built directly over the bed of that stream, and it crosses on bridges three times.

As in nearly all German Government works the primary object of the Stadtbahn was military, to afford facilities for the passage of troops through the city without transfer, and for massing them readily at any point. At the same time the local traffic was kept in mind, and arrangements made for its accommodation. The road has four tracks for its entire length, two of them being used exclusively for through and suburban trains of the different roads, the other two for the local trains, of which there are two classes, one running over the city road only, the other over the city road and the Ringbahn, or circuit road also.

The total length of the Stadtbahn is 7.55 miles, of which 1.05 miles are simple earth-work embankment; 0.42 mile walled embankment; 1.13 miles iron bridges and viaducts, and 4.95 miles masonry viaduct. The bridges include 65 iron bridges over streets; an iron viaduct over the Humboldstrafen; two iron bridges over the Spree and a masonry bridge over the same river. As already mentioned, at one point, near the Jannowitz Bridge, the masonry viaduct is directly over the bed of the river for a distance of 0.34 mile.

As may be inferred from the description of the road, it does not follow any of the city streets, but is built through the blocks. Where the masonry viaduct is used, the archways are utilized as storehouses and work-shops, very much in the same way as in the approaches to the Brooklyn Bridge in New York. To give access to these, parallel streets have been opened on each side of the road. These parallel streets are not yet all completed, but are being gradually extended.

The width of the road for four tracks is 52½ ft. This is increased at and near the stations, the platforms being placed between the tracks. At the larger stations, as named below, there are two platforms, one for the through and one for the local tracks; at the minor stations there is a platform for the local tracks only.

The stations are two stories high, the lower story, of brick, on a level with the street, containing the ticket office, waiting rooms, etc.; the upper story is of iron, and is an open shed or train-house, covering the platforms. At the larger stations, where through trains stop, there are baggage rooms, and hydraulic elevators are provided for raising the baggage to the platforms. At each station there is a block signal.

The rails used are of steel (56 lbs. per yard) and are supported on longitudinal iron sleepers of the Harmann pattern.

For the through trains no special class of locomotives is used, the engines of the different roads running the trains. For the local trains engines of a pattern very common in Germany are used, having four driving-wheels coupled and two leading wheels. The later engines (somewhat heavier than those first used) have cylinders 14.2 in. diameter and 22.8 in. stroke, and driving-wheels 62.8 in. diameter. The fuel used is coke, from which there is very little smoke. The local trains have special cars built for this service; they are lighter than the ordinary cars and are of second and third class only, no first-class being provided.

The total cost of the Stadtbahn was about $16,212,000, or $2,047,285 per mile. Of the total cost of the road about 40½ per cent. was for land and 59½ per cent. for construction.

Trains are run on the block system, each of the stations having a signal station. Semaphores are used, the signals being transmitted by electricity on the Siemens-Halske system. Two classes of trains, as already noted, pass over the Stadtbahn, the through passenger trains, of which there were at a recent date 112 daily, running at no regular intervals. The local trains run at intervals of 10 minutes during the busier hours of the day, this interval being reduced to 5 minutes on holidays and other special occasions. On ordinary days 280 trains a day are run. The highest speed allowed is 28 miles an hour. No freight trains pass over the Stadtbahn, all exchange of freight cars being made over the Ringbahn. The charge for second-class tickets is about 15 cents for the whole length of the line and 10 cents for shorter distances; for third-class, 10 and 5 cents. Workmen's tickets are issued at a lower rate; they are good only before 8 A. M. or after 4 P. M.

The population of Berlin is not far from that of New York. The city is nearly circular in shape, being thus much less favorable to the development of a single line of travel than New York. Even with allowance for this, however, the people of Berlin do not seem to patronize the elevated road as much as might be expected. The number of local passengers carried for four years has been as follows:

1882	8,524,348
1883 (Exposition year)	10,116,826
1884	9,157,762
1885	10,196,028

The number carried in 1885 was an average of 27,934 per day. The elevated line of lighest traffic in New York last year carried about 25 per cent. more than this; the line of heaviest traffic over 4½ times as many, while the total traffic of the four New York lines was over ten times as great.

The total cost of operating the Stadtbahn in 1885 was about $900,000; the receipts from local traffic were about $800,000. The earnings from the through trains, however, probably exceeded the deficit; they were not given separately, but are included in the general receipts of those lines. It is to be remembered that the road, having been built for military reasons chiefly, has been constructed and operated in a more expensive manner that if it had been a commercial undertaking.

The facts given above are derived chiefly from a pamphlet recently published in Paris by MM. Gaudin and Zuber.

Rope Transmission of Power.

THE *Iron Age* says: "Systems of rope transmission for power purposes have been in use for many years, but it is only quite recently that they have given promise of being more generally recognized as a convenient aud efficient means of accomplishing the ends for which they were designed. The results which have been obtained with them, it is true, have not always been of uniform excellence, mainly, however, because designers have in some cases failed to recognize properly the requirements of good working. Where rope driving has been tried and has failed, examination has almost invariably revealed a disregard of correct principles of construction, and has shown nothing calculated to detract from the favor in which the system is held, especially where a continuous high speed is required. As regards the comparative cost of rope and other systems of gearing, and the average life of a rope of the kind ordinarily used in manufacturing establishments, it is difficult to get any precise data. As compared with leather belting, however, we have seen figures reflecting very favorably on rope transmission, the relative costs having been in the proportion of about eight to one. As to the life of a rope it has been roughly estimated that with proper usage it should not be less than about seven years. Cases where ropes have suddenly broken are, moreover, few in number, the risk in this respect being reduced to a minimum by the fact that any defects in a rope, arising either from wear or other causes, will show themselves long before the point of danger is reached. In mill districts, particularly, engineers have not been slow to avail themselves of these advantages, and with the cotton rope which is there chiefly used, most satisfactory performances are recorded. It is but natural, under these circumstances, that the field of usefulness of rope gearing is gradually being extended—some enthusiastic supporters of the system having even gone so far as to advocate it to the exclusion of almost all other means.

Manufactures.

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THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 185.)

CHAPTER V.

SMOKE STACKS AND SPARK ARRESTERS.

There is probably no part of a locomotive, unless it be the valve gear, on which so much ingenuity has been exercised as on spark arresters. The very first engines built at the Rogers Works had some kind of bonnet or wire netting on the top of the chimney to "catch the sparks," and, in the article on page 14 reprinted from the *American Railroad Journal*, of December, 1839, it will be seen that at that time an inverted cone was placed on the "axis of the smoke-pipe to protect the wire

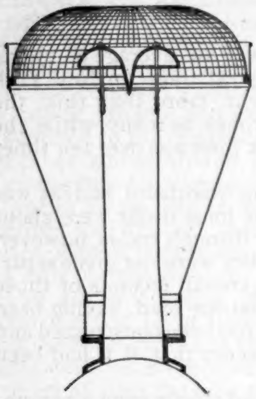


Fig. 109.
1854.—Wood.

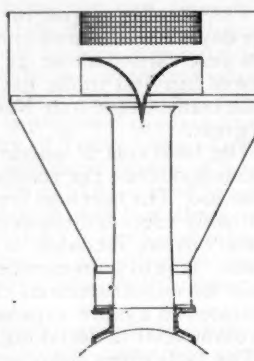


Fig. 110.
1854.—Wood.

gauze." Unfortunately there are no drawings extant of any of these early spark arresters. Figs. 109 to 137, however, give examples of later practice, and show different devices demanded by those who ordered locomotives of the Rogers Works. The date when they were first made and the fuel used is given under each of the figures.

Fig. 109 is what is called a bonnet stack, on account of the bonnet or hood of wire netting over the top. It was used for burning both wood and coal.

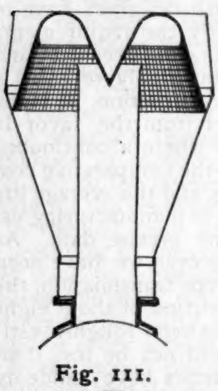


Fig. 111.
1854.—Wood.

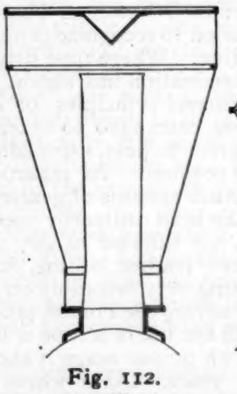


Fig. 112.
1856.—Wood.

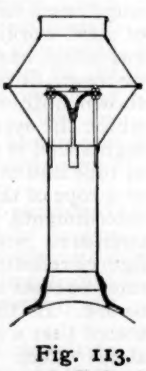


Fig. 113.
1858—Coal and Wood.

Fig. 110 had a deflecting cone and netting in the form of a cylinder over it.

Fig. 111 had a large deflecting cone with wire netting in conical form attached to the lower edge of the deflector.

Fig 112 had a cone with flat horizontal netting of annular form around it.

Fig. 113 is known as the diamond stack, from the form of the outline of its top. It had a deflecting cone, but no netting.

Fig. 114 had a curious shaped deflecting cone and a cast-iron guard at *A A*, to protect the sheet-iron of the outside casing from the action of the cinders. It also had an annular opening, *B B*, around the top, the supposition being that the air coming in contact with the inclined surface *C C*, would be deflected upwards through the opening *B B*, and thus create an induced upward current out of the chimney.

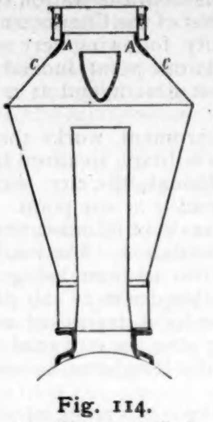


Fig. 114.
1860.—Bituminous Coal.

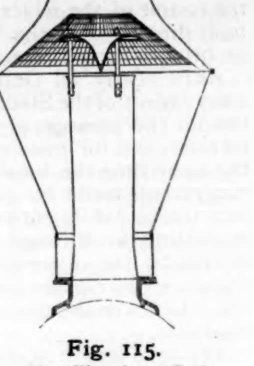
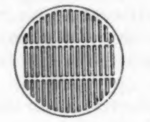


Fig. 115.
1862.—Bituminous Coal.

Fig. 115 had a deflector with a conical netting over it, which was open at the top.

Fig. 116 was the same as Fig. 115, but of different form.



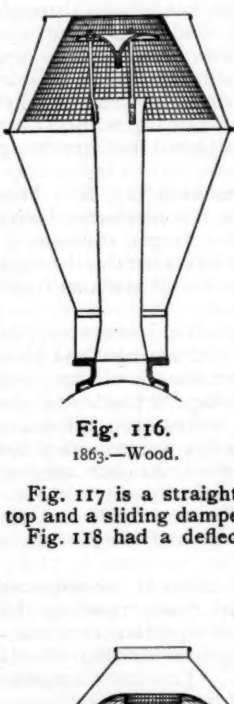


Fig. 116.
1863.—Wood.

Fig. 117.
1864.—Anthracite Coal.

Fig. 118.
1866.—Bitum. Coal.

Fig. 117 is a straight chimney with a cast-iron grate at the top and a sliding damper at the base.

Fig. 118 had a deflector with a netting over it, which was open in the middle. The opening was surrounded by a cylindrical shaped netting, as shown.

Fig. 119.
1867.—Bituminous Coal.

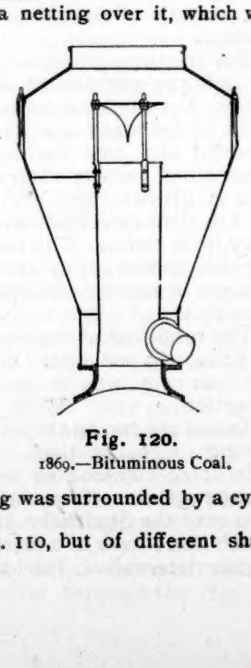


Fig. 120.
1869.—Bituminous Coal.

Fig. 119 was the same as Fig. 110, but of different shape and proportions.

Fig. 120 had a deflector with a very large casing or receptacle for sparks.

In Fig. 121 the netting was placed horizontally over the deflector.

Fig. 122 represents the celebrated Radley & Hunter stack,

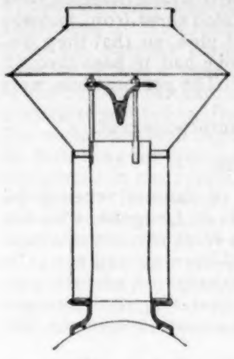


Fig. 121.
1869.—Bituminous Coal.

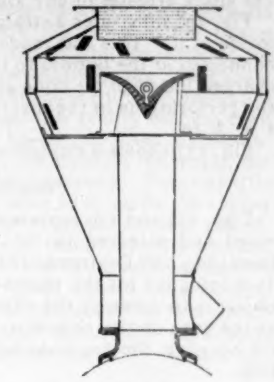


Fig. 122.
1870.—Wood.

which was at one time very generally used for wood-burning locomotives.

Fig. 123 has a conical shaped netting over the deflector, with an opening in the center surrounded by another netting of cylindrical shape.

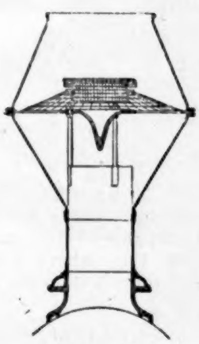


Fig. 123.
1872.—Wood and Coal.

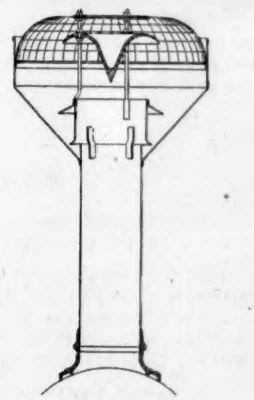


Fig. 124.
1872.—Wood.

Fig. 124 has a deflector with a wire-netting bonnet over it.

Fig. 125 is similar to fig. 124.

Fig. 126 has a deflector with a circular opening above it, and cylindrical guard around the edge made of perforated sheet-iron or copper.

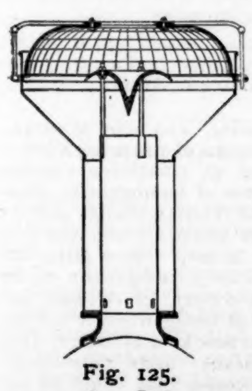


Fig. 125.
1872.—Coal.

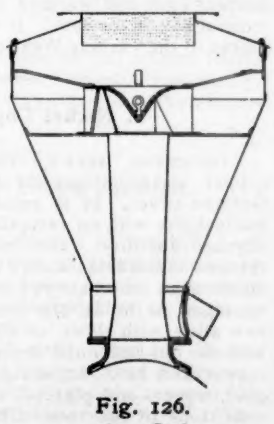


Fig. 126.
1873.—Coal.

Fig. 127 shows what is called a "straight" stack, and has no spark-arresting attachments.

Fig. 128 represents the Fontaine stack. This has a deflector, *D*, to which a shield *S S*, is attached. Between the shield and the outer casing there is space for the passage of the products of combustion, which escape in the direction indicated by the darts.

Figs. 129 had an outside case or receptacle for sparks which was unusually large. It had a deflector surmounted with an inverted cone of wire netting. This forms a guard for the opening at the top so that all the smoke must pass through the netting to escape into the open air.

Fig. 130 shows a stack with a spark arrester patented by

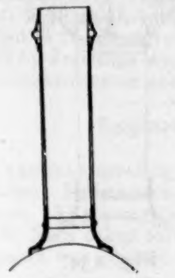


Fig. 127.
1879.—Bituminous Coal.

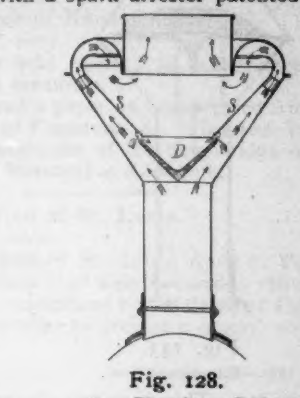


Fig. 128.
1879.—Bituminous Coal.

Wm. S. Hudson in 1877. The reflector is formed of what Mr. Hudson described as "peculiarly curved screw blades," which are shown on plan in the engraving. "The gaseous products of combustion," the inventor says in his specification, "mingled with more or less small masses of coal in various conditions,

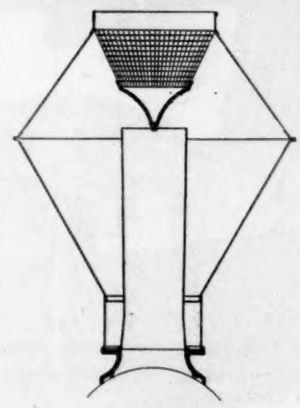


Fig. 129.
1879.—Bituminous Coal.

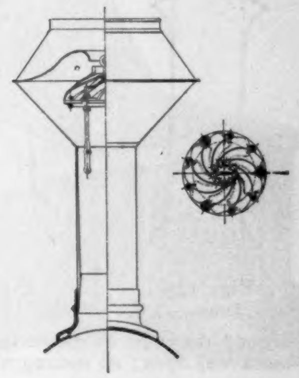


Fig. 130.
1881.—Bituminous Coal.

are thrown violenty upward through the cylindrical chimney, and, striking in the hollow interior of the dome-like set of wings, are thrown into a spiral motion without completely interrupting their upward motion. The solid matter is pro-

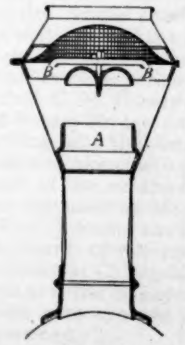


Fig. 131.
1881.—Bituminous Coal.

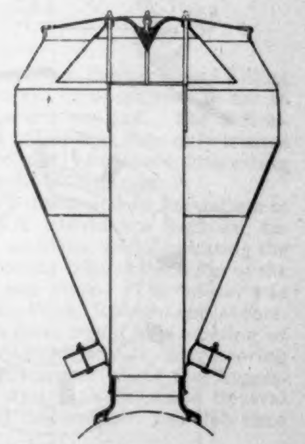


Fig. 132.
1881.—Bituminous Coal.

jected against the wire netting. A portion of the gaseous matter follows the same course, and another portion moves inward, and, passing freely upward through the open space in the center."

Fig. 131 is provided with a casting, *A*, which forms what was

called a stricture, for some purpose not clearly understood. The usual deflector was suspended from a casting, *B B*, with radial arms meeting in the center.

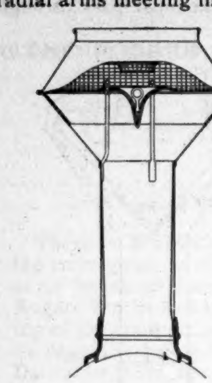


Fig. 133.
1882.—Bituminous Coal.

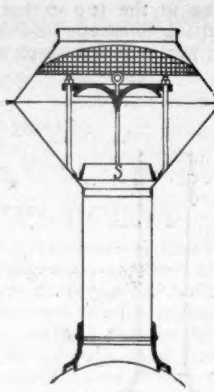


Fig. 134.
1882.—Bituminous Coal.

Fig. 132. This stack had a large receptacle for sparks, with a deflector placed at the top. The latter had a sheet-iron guard

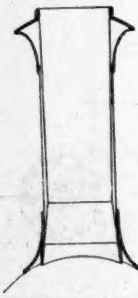


Fig. 135.
1882.—Bitum. Coal.

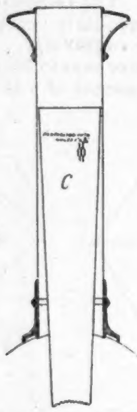


Fig. 136.
1882.—Bitum. Coal.

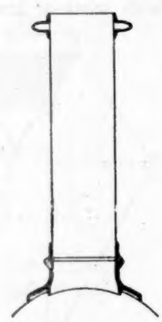
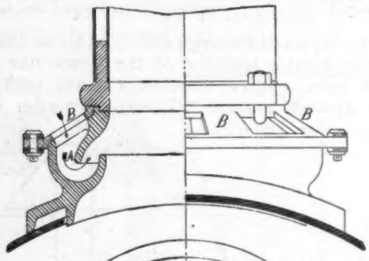


Fig. 137.
1882.—Anthra. Coal.

around the edge, as shown in the engraving. The top of the stack was open; no netting was used.

Fig. 138.



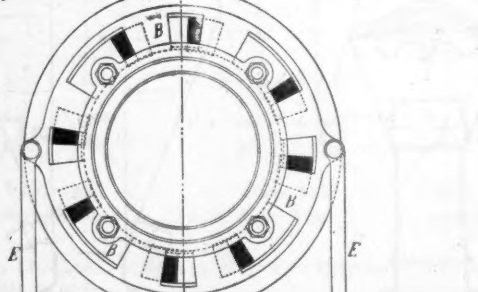


Fig. 139.

Fig. 133 had a deflector with wire netting over it, as shown.

Fig. 134 was similar to fig. 133, but of somewhat different proportions. It also had what was called a "stricture" or contraction of the opening at *S*. The effect of this was to concentrate the escaping current and cause the sparks to impinge directly against the deflector.

Fig. 135 represents what is called a "straight" stack without spark arrester of any kind.

Fig. 136 illustrates a straight stack with a long inverted cone inside of it. This was made of perforated sheet-iron, and was connected at the bottom to the exhaust pipe, so that they discharged inside of the cone and the smoke had to pass through the perforations in the inverted cone. The perforations were $1 \times \frac{9}{32}$ in.

Fig. 137 shows a straight stack for anthracite coal.

CHIMNEY DAMPERS.

Figs. 138 and 139 represent a form of damper recently devised and patented in 1885 by Mr. H. A. Luttgens, who has been the Chief Draftsman in the Rogers Works for 28 years past. It is intended for the chimneys of coal-burning engines. Its object is to diminish the effect of the exhaust by admitting air at the base of the chimney, and thus obviating the necessity for opening the fire-door and admitting cold air into the fire-box.

In constructing the damper the base of the chimney is made of the form shown in half section on the left side of fig. 138, from which it will be seen that there are cavities *A*, through which air is admitted, as indicated by the darts. The outer openings of these cavities are shown by the dark shading and dotted lines in the plan, fig. 139. On top of these openings is a circular valve or cover with openings corresponding to those in the base of the chimney. This valve by being turned a part of a revolution by means of the links *E*, *E*, and lever *C*, *C*, which is connected with the cab by a rod *D*, will cover or uncover the openings leading to the cavities in the base of the chimneys, and thus air may be admitted to or shut off from the chimney at pleasure.

(*To be continued.*)

Manufacturing Notes.

A NEW nail mill and rolling mill has been built at Watsontown, Pa., and is nearly ready to begin work.

THE Catasauqua Iron Company has bought the plate mill formerly owned by the Abbott Iron Company, of Baltimore, and has removed the plant to Ferndale, Pa., where a new building, 80 x 500 ft. is nearly finished to receive it. The mill will roll boiler plate up to 8 ft. wide.

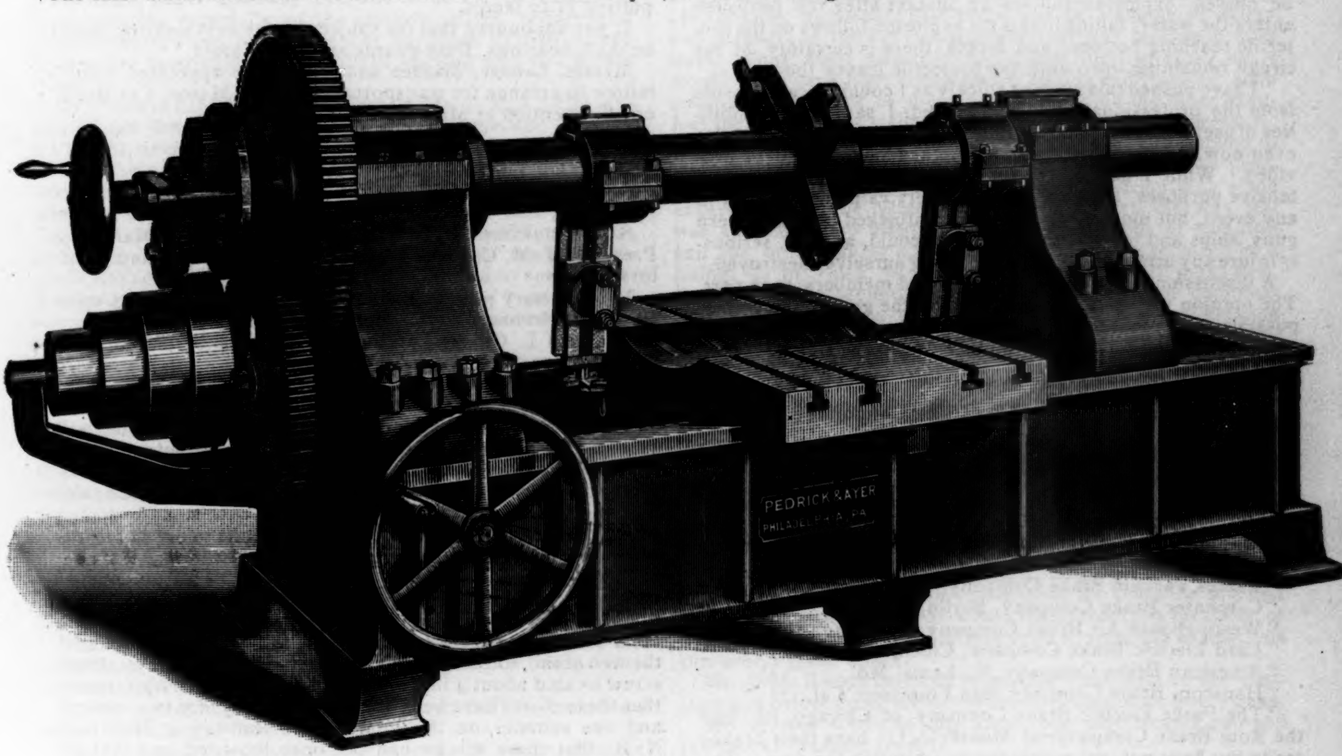
THE Lehigh Car Company at Stemton, Pa., is to be reorganized. The property is now owned by the Allentown National Bank.

THE new Westinghouse building for the joint offices of the various Westinghouse companies in Pittsburgh is being rapidly pushed. It will be fire-proof throughout. It has a floor plan of 80 x 110 ft. and is 200 ft. in height, with three high-speed passenger elevators. It will be lit throughout with incandescent light and warmed by indirect steam radiation, with natural gas as the fuel. It will be occupied exclusively by the offices of the various Westinghouse companies.

A Nickel Copper Aluminum Alloy.

"LECHESNE," says a French magazine, is an alloy of nickel, copper, and aluminum for the production of a superior kind of German silver. It is recommended as combining absolute malleability with an exceptional degree of homogeneity, tenacity and ductility. The inventor, M. Thirion, claims also for the new metal less liability to oxidize and to act as a heat conductor than other alloys heretofore in use. These latter advantages, he holds, are conspicuous on a comparison of the new alloy with those of nickel and copper for coinage, and with the old-fashioned descriptions of German silver (nickel, copper and zinc), or, again, with the best kind of latten. Like gold, silver, and platina, the "lechesne" alloy satisfies the conditions of the most difficult processes that could be applied, such as hammering, drawing and deep chasing or punching, especially in ornamental work. The distinctive feature of this metal consists in the addition to the binary alloy (nickel and copper) of a quantity of aluminum, calculated according to the proportion of the nickel. The aluminum is introduced a few moments before the casting process, care being taken to send it to the bottom of the fusion, and to ensure thorough distribution throughout the mass by vigorous mixing. Its combination is facilitated by its natural affinity to both copper

and nickel. The proportion of the aluminum entering into the alloy is as follows: 165 centigrammes per kilogramme of alloy containing 10 per cent. of nickel. Any attempt to deoxidize an alloy of nickel and copper in which the aluminum was not carefully introduced toward the close of the fusion would lead to carbureting. If it was sought, for instance, to expel the surplus carbon by superheating, the inadequate quantity of free oxvgen present would prevent the combustion of the carbon, so that the metal would in reality become even more deteriorated by the process by an increased oxidation. The aluminum both deoxidizes and decarburets the metal, but the following precautions should be observed: The nickel is first placed in the crucible, and as soon as it melts the copper is gradually introduced, the vessel, of course, being closed. When the two metals are in a state of fusion they are puddled together, then the alloy is reheated and the aluminum thrown in, the temperture being rapidly raised almost to a boiling point. In the next place, the alloy is cast very hot, this operation being effected promptly and with the utmost regularity. The chief malleableness of the article is derived from the copper, which imparts a property and a tone in that respect found lacking in the nickel. The aluminum suddenly, but surely, oxidizes the alloy, burning away every trace of carbon introduced into the crucible.



CYLINDER BORING AND FACING MACHINE.

New Cylinder Boring and Facing Machine.

THIS machine, the general construction of which is well shown by the accompanying illustration, is intended for heavy work. It is, accordingly, built very heavy and is powerfully geared. The size shown will bore cylinders from 10 in. to 25 in. diameter; other sizes are built also.

The bar is solid forged steel, with steel screw and bronze thrust-bearings. The feed-casing is made to feed either way and has two changes, to operate which it is only necessary to push in or pull out a pin in the center of the hand-wheel. The facing head can be placed on the bar quickly, and in any place desired, and, if necessary, can be operated at the same time the cylinder is being bored. The bed is movable on the shears, and is easily set in position by the hand-wheel at the forward end of the machine. The cutter-heads have a long bearing on the bar, and are arranged for four tools, that number being found by experience to be the most desirable, as it distributes the stress or strain on the bar, and four times the metal can be removed.

These machines are made at the L. B. Flanders Machine Works of Messrs. Pedrick & Ayer, in Philadelphia.

Proceedings of Societies.

Engineers' Club of Kansas City.

A REGULAR meeting was held April 4, at which several gentlemen were proposed as members.

Mr. William D. Jenkins read a paper on Compressed Air as applied to the Construction of Foundations. This was illustrated by drawings and photographs of the new bridge now under construction over the Missouri at Randolph.

Engineer's Club of St. Louis.

A REGULAR meeting was held in St. Louis, April 6, Vice-President Holman in the chair; 28 members and 4 visitors present. The commitee on resolutions on the death of Capt. Jas. B. Eads asked for further time to prepare a report, which extension was granted.

S. Bent Russell then read a paper on Draining and Filling Water Mains, describing the system of operations in use in this city, where shut-offs average one per day. The difficulties met with and the precautions to be taken were duly treated upon. In the discussion Mr. Holman gave some interesting points in his experience, bearing on this question.

Prof. C. M. Woodward opened a discussion on the failure of the Bussey Bridge on the Boston & Providence Railroad, describing fully the nature of the accident and illustrating the details by sketches on the blackboard. His explanation of the cause of the accident was full and clear. The matter was also discussed by Messrs. Seddon, Frith, Johnson and Moore.

Prof. Johnson announced that there would be a meeting of the board of managers of the Association of Engineering Societies at Chicago at an early date, and asked that suggestions as to the management of the Association be made. Several topics were brought forward and discussed. The club then adjourned.

Military Service Institution.

AT the meeting held at Governor's Island, April 14, Lieuten- E. L. Zalinski read a paper on his pneumatic gun for throwing dynamite shells. After referring to the improvements made, and especially to the increase of air pressure, Lieutenant Zalinski said:

"I have repeatedly denied the statement that the gun is of my invention. I have, however, given direction to its develop-

ment as a practical military appliance. I am not a mechanical engineer, and could not have worked out the mechanical details unassisted. This has been done by Mr. Nat. W. Pratt, of the Babcock & Wilcox Company, Mechanical Engineer of the Dynamite Gun Company, Mr. George W. Reynolds and Mr. Charles Emory.

"With a percussion cap in front a shell in exploding failed to produce any marked effect. It was assumed that the gases envolved by the explosion of the layers in front tended to throw back the gases evolved afterward—a certain amount of time being required to explode the entire charge. This was the point that led to the invention of the electrical fuse. It is so devised and arranged in the shell that the circuit is closed by means of a sensitive plunger an instant before the body of the projectile has struck the target. Indeed the latest projectiles containing large charges, have two or more batteries, so as to explode the charge at several points immediately. The solution of problem resulted in a primer which, in striking the target, explodes the charge an instant before impact; if a ship be missed, explosion follows an instant after the projectile enters the water; failing in this the explosion follows on the projectile reaching bottom; and fourth there is certainty of the circuit remaining open until the projectile leaves the gun.

"I have pushed this work as quickly as I could, because, aside from the professional interest involved, I saw in it possibilities of usefulness in cases of public emergencies which may arise even now, before a regular modern armament could be provided. While I have never considered it all-sufficient for defensive purposes, I have thought it a very valuable auxiliary in any event, but most of all if we were attacked before modern guns, ships and forts are provided, we could, at least, seriously injure any attacking force before being ourselves destroyed."

A discussion followed in which several members took part. The opinion was expressed that rifling the gun would not be possible, on account of the danger of a premature explosion from the oscillation of the projectile due to the rifling.

Master Car-Builders' Brake Committee.

MR. G. W. RHODES, Chairman of the M. C. B. Brake Committee, has issued the following notice:

"Up to date the following brake companies have notified the committee they have made arrangements for cars and engines and will be present at the Burlington Brake tests commencing May 9, next.

"Eames Vacuum Brake Company, Boston, Mass.,
"Carpenter Brake Company, Berlin, Germany.,
"Westinghouse Air Brake Company, Pittsburgh, Pa.,
"Card Electric Brake Company, Cincinnati, O.,
"American Brake Company, St. Louis, Mo.,
"Hanscom Brake Company, San Francisco, Cal.,

"The Parke Electric Brake Company, of Chicago, Ill., and the Rote Brake Company, of Mansfield, O., have their brakes ready but have not yet succeeded in arranging for cars. The committee will not debar them or any other company from the tests, providing they get their cars to Burlington by May 9, 1887."

New England Railroad Club.

THE regular monthly meeting of this club was held in Boston, April 13, President Lauder in the chair.

The regular subject–the Lighting of Passenger Cars–was taken up.

Ex-Governor Howard, representing the Pintsch Lighting Company, explained that system of gas lighting at some length. He said the actual cost is about $12 per car per year, exclusive of cost of fitting up the cars and the plant for furnishing. Including those items, the cost is not over $40 per car per year. He expressed his belief that, where there is a 300° test required of oil used in cars, there is not a railroad but violates the law.

Mr. Adams and Mr. Curtis both took exception to the latter statement, claiming that frequent tests made by the State Inspector demonstrated that the oils were up to the test.

Mr. Coney explained that he had had large experience in manufacturing kerosene, and he very much doubted if the oil used would stand the 300° test when made by the best instruments. He declared he did not believe any accident ever occurred with oil having a fire test of 150°.

President Lauder said he hoped the railroads and the public would not lose their heads because of recent accidents. He thought the present system was a good one, and plenty of light can be obtained, if enough lamps are put in, though the more lamps put in the more heat is generated. He knew of no instance where cars had been set on fire by the lamps, as a very slight shock invariably puts the light out. He thought the heavy expense of lighting with electricity would prevent its general use at present.

Mr. Fowler spoke of the trouble in not taking care of the lamps properly, and said that sometimes the brakemen do not turn up the wicks high enough to show the flame.

Gen. Elbert Wheeler, Treasurer of the Wheeler Reflector Company, stated that, with proper reflectors, he could give the same amount of light with 12 electric lamps as is given by the 20 in the Boston & Albany cars.

Mr. Marden (Fitchburg Railroad) said that he had put in one car five lamps with the Acme burner, and he believed that the car is the best lighted of any running out of Boston, with, perhaps, the exception of the Boston & Albany's electric lighted cars. He believed, however, in electric lights, and is fitting up a car which is to be lighted by storage batteries furnished by the American Accumulator Company. Outside of the work being done by him, the entire expense of fitting up the car, including the accumulators, is only $375. He is putting in 12 lamps.

It was announced that the subject for the next meeting would be Axle-bearings, Dust-guards and Lubricators.

Messrs. Lauder, Marden and Ford were appointed a committee to arrange for transportation to the Master Car-Builders' Convention at Minneapolis in June.

Engineers' Club of Philadelphia.

A REGULAR meeting was held in Philadelphia, March 19, President T. M. Cheman in the chair; 32 members and 3 visitors present.

The Secretary presented, for Mr. Wilfred Lewis, a note upon Phosphor Bronze Wire for Helical Springs.

Mr. John L. Gill, Jr., presented a paper on Screw Threads, in which he argued against the system of screw threads now in general use.

Mr. H. H. Sintzenich, introduced by Mr. Henry G. Morris, exhibited and described a Rail Chair which he had devised with a view of overcoming the objections to joints bolted through the webs of the rails, and of obviating the necessity for brace or check-blocks on curves. The lack of continuity and consequent wear of rail ends, and the constant loosening of nuts, were noted as the principal objections to present forms of rail unions.

The invention consists of two pieces of cast-iron, one of which bears against one side of the web of the rail, and is held to the tie by three ⅝-in. coach screws, 6 in. long, while the other piece abuts against the first and against the other side of the web of rail, forming a clutch which is held in place by a single screw located about 4 in. from the rail. Mr. Sintzenich stated that these chairs have been used continuously, for two winters and one summer, on the Intercolonial Railway at Moncton, N. B., that these screws had not once loosened, and that no other objection to the joint had been discovered.

The Secretary presented, for Mr. F. H. Lewis, a paper upon Clapp-Griffiths Steel for Structural Work.

He describes the method of manufacture as compared with the Bessemer process and the adaptability of the required plant to mills with a small output, and gives the results of very full physical tests of specimens, with a few chemical analyses. Test specimens were exhibited.

In conclusion he says: "Some tests of full-sized eye-bars of this metal have been made with generally favorable results; about three-fourths of the bars, it is said, being satisfactory. I have not been able to get the figures. Altogether, the showing, as regards quality of material, is good, and the evidence of a considerable period of time and a large number of tests seems to be conclusive that the specifications for mild structural steel can be readily filled by the Clapp-Griffiths metal with a percentage of rejection certainly under 5.

"As regards the question of whether the steel is better than Bessemer or not, as has been claimed, I can only say that any one who sees his way clear to argue that question is welcome to the floor."

Mr. Percival Roberts, Jr., followed with some discussion, questioning whether any advance in steel manufacture could be claimed for this process.

The Secretary presented, for Mr. Emile Low, a paper on Maps for Railroad Surveys. In this Mr. Low recommends the use of separate sheets, 19 × 24 in., which, on the scale of 200 ft. to 1 in., which he prefers, would each include about one mile of the road. The convenience of handling and filing these sheets, as compared with large drawings, would be very great. They could also be conveniently carried in the field; for this purpose Mr. Low showed a convenient portfolio,

which could also be used as a drawing-board. He gave various systems of arrangements of continuous sheets with reference to the meridian, convenience in tracing from two or more sheets, and other points.

A REGULAR meeting was held in Philadelphia, April 2, President T. M. Cleeman in the chair; 32 members and 5 visitors present. The following were elected active members of the Club: Messrs. Conway H. Day, Lino F. Rondinella, Henry S. Prichard, Eugene A. Rhoads, A. Wells Robinson, George N. Bell, Joseph Powell, Jr., and Griffith W. Jones.

The Secretary presented, for Mr. Theo. Low, Notes on Railroad Construction. The paper treats of detail in the management of surveys and plans, forms of note books, methods of accurate measures for bridge work, coffer-dams, etc. It embodies many excellent suggestions as to practical details.

Mr. F. W. Whiting, introduced by Mr. L. C. Madeira, Jr., presented a paper upon the Prevention of the Spreading of Fires, treating especially of the relation of the proper and scientific design and construction of buildings to their safety from entire destruction in case of the starting of a fire within them.

Mr. Francis Lightfoot, introduced by Mr. J. Kay Little, exhibited and described a Stamp Splice, Tongue and Groove Rail Joint, devised by him. The ends of the rails are stamped, at the heat at which they leave the last roll, into such shape that they will halve over or against each other, and sustain each other by an arrangement of tongues and grooves. They are simply bolted together without any additional plate or fixture. They have been laid on a portion of the Pennsylvania Railroad, where they are being subjected to severe test. The inventor claims that the test, to date, has been entirely successful, and that many advantages have been obtained over other forms of joint.

Mr. Max Livingston presented a paper on Petroleum, in which, after reviewing the history of its production in America, he gave an account of the Russian oil fields.

The Secretary presented a communication from Mr. Gratz Mordecai, suggesting an active interest on the part of the Club in local engineering matters and public work. It was referred to the Board of Directors.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, on the evening of April 6.

The Committee on the 24-hour System reported that the question of the adoption ot that systen would be taken up by the General Time Convention.

It was announced that Harry Gilbert Darwin had been elected a Fellow of the Society.

The following elections were announced: *Members:* Horace Andrews, City Engineer and Surveyor, Albany, N. Y.; Frank Graef Darlington, Superintendent Cincinnati & Muskingum Valley, Zanesville, O.; Joseph Thompson Dodge, Chief Engineer Montana Central, Helena, Mont.; Edward Adolph Hermann, Assistant Engineer Cincinnati, Indianapolis, St. Louis & Chicago, Indianapolis, Ind.; Henry Clay Jennings, Assistant Engineer, Chicago, Milwaukee & St. Paul, Milwaukee, Wis.; Samuel Fisher Morris, Assistant Engineer, New Croton Aqueduct, Yonkers, N. Y.; Benjamin Franklin Thomas, U. S. Assistant Engineer in charge Big Sandy River, Louisa, Ky. *Juniors:* George McGrew Farley, Engineer Maintenance of Way Northwestern Ohio Railroad, Toledo, O.; Gideon Frederick Haynes, Advisory Engineer mills of William Roberts, Waltham, Mass.

The subject for the evening—the discussion of Mr. Wm. Metcalf's paper on Steel—was then taken up.

Lientenant Jacques, U. S. N., read a written discussion in which, while speaking in the highest terms of Mr. Metcalf as an expert, he dissented from his views on certain points. The offer of the Bethlehem Works, to make the steel required under the recent competition, he considered a guarantee that the system of building up steel guns is the best. He considered the Terre Noire experiments as also proving that a steel gun cannot be cast successfully. He asked Mr. Metcalf why, if hammering and rolling were not beneficial, he resorted to these processes so universally in his own shops.

To this Mr. Metcalf replied that they were called upon for about 6,000 sizes and different shapes, and hammering and rolling were the most economical methods for producing them. He did not believe there were any beneficial effects resulting.

Dr. R. J. Gatling then read a written discussion, in which he held that hard steel was not a safe material for guns. He advocated the use of mild steel, and believed that large guns could be cast successfully. He continued at some length, upholding Mr. Metcalf's views, that gun-steel should not be hammered, pointing out the dangers from overheating and overannealing, etc.

Mr. F. Collingwood read a brief paper expressing the opinion that, when experts such as Mr. Metcalf expressed so positive an opinion respecting the possibility of casting large guns successfully on the Rodman plan, it was un-American for us to blindly follow the lead of other nations without first following the lead of our *own* traditions, and proving the truth or falsity of Mr. Metcalf's position by actual test.

Mr. A. H. Emery said that while he had given the subject of guns and projectiles very considerable attention, his greater experience was in the behavior of the materials which would enter into them. He acknowledged the good work of the Rodman cast-iron gun, but pointed out that the conditions had changed very much in the last 20 years, in weight of charge and projectile, muzzle velocity and initial pressure on the gun. He thought, moreover, that there was an element of safety and strength in the old cast-iron gun that was lacking in mild steel. Thus, while cast-iron had a low limit of elasticity, it would bear very high compressive strains and transmit such strains without flow of metal. Mild steel, on the other hand, met the limit of resistance to this flow at 40,000 lbs. pressure, and pressures of more than 30,000 lbs. were now applied to guns, with a rapid tendency to increase this pressure in practice. The speaker illustrated this theory by describing some experiments at the Watertown Arsenal, where the wax test was applied to two similar cylinders, one wholly of cast-iron and the other having a portion of the cast-iron replaced by a lining, $\frac{8}{10}$ in. thick, of wrought-iron; the latter burst first, though it would seem to have had in it the stronger combination of metals. The explanation was that the wrought-iron commenced to flow under the pressure applied and assisted the wax in bursting the outer shell of cast-iron instead of strengthening it. Mr. Emery described the process of drawing down steel bars by machine hammering and testified to the good qualities of this steel, and for his ideal gun only asked for a piece of metal of similar quality 4 ft. square and about 40 ft. long. But he did not expect to live long enough to see such a mass made equal in quality to the smaller sections first referred to. He thought, therefore, to insure the best material and perfect homogeneousness, we must depend upon built-up guns made from comparatively small parts. He referred to the good work done by exceptionally hard steel 6 in. pins used in his testing machine, which have stood for years the severest shocks and strains, such as would result from the breaking of a test-bar, with 750,000 lbs. stress upon it, recoiling against this pin over a $\frac{3}{4}$-in. space.

Mr. J. M. Knapp believed in making a full trial of the cast-steel gun before going further in the construction of heavy guns.

Mr. Dorsey spoke of the Armstrong wire-wound gun and the results obtained from it.

Mr. Theodore Cooper said that his experience had taught him to prefer mild steel for structural purposes on account of its greater reliability. He believed that large guns could be successfully made of cast-steel, and that they would be superior to the best built-up guns. The speaker, in discussing the bursting effect in guns, called attention to the interesting arrangement of the lines of flow, or stress lines, in passing from the bore to the exterior of the gun barrel; the author had already addressed the Society on this subject in a paper on the effect of punching steel, and the same lines had been afterward noticed by a Russian engineer. These curved lines cross each other at an angle of about 45°, and are so well defined under stress, that they can be etched and printed from.

Prof. De Volson Wood spoke briefly of the relative action of a bursting charge on solid and built-up cylinders.

A lengthy paper, by Mr. John Coffin, was partly read, which was largely illustrated by diagrams, treating mainly on the condition of carbon in steel, as modified by working. The reading was not completed, owing to the lateness of the hour.

Besides the papers already mentioned, written discussions were presented (but not read) by Commander C. F. Goodrich, Prof. John W. Langly, Lieutenant Commander F. M. Barber, Lieutenants Arthur M. Knight and R. R. Ingersoll, Messrs. Henry M. Howe, D. L. Whittemore, Wm. Sellers, M. J. Becker, L. L. Buck, W. H. Burr, A. Gottlieb, A. E. Hunt, C. A. Marshall, P. Roberts, Jr., Joseph M. Wilson and S. T. Wagner. No subject before the Society for a long time has called out such a discussion.

Mr. Metcalf, being called on to close the discussion, expressed disappointment that it had gone so much in the direction of gun manufacture. He referred to other parts of the discussion not yet read, showing variations in carbon utterly

disproving the conclusions reached by Mr. Coffin. His interest does not lie in gun manufacture, but in the use of steel structurally. He had pointed out four or five fundamental facts as a result of the manufacture of steel and testing it during 20 years, and he presented them for the use of the profession and an advance in the intelligent use of the material by engineers. He cautioned them against accepting refinements as to carbides, carbon of cementation, etc. With regard to steel guns, he thought that it was very important to remember the susceptibility of the metal to changes under the influence of heat, and asked a careful consideration of the subject.

AT the meeting of April 20, the Secretary announced that the Committee had decided to hold the annual meeting at the Hotel Kaaterskill in the Catskill Mountains, in the first week of July. There would be a steamboat trip up the Hudson, an inspection of the work on the Poughkeepsie Bridge and other excursions; details to be announced hereafter.

The discussion of Mr. Metcalf's paper on Steel was then taken up again. The Secretary read abstracts of the written discussions including those of Mr. E. J. Whittemore, who referred to the loss of strength by steel in passing through shop manipulations.

Commander C. F. Goodrich favored a trial of cast-steel guns.

Lieutenant Commander Barber also believed that cast-steel guns should be tried, although somewhat doubtful of their success on account of the difficulty of making the castings. He noted that nearly all the important improvements in guns adopted in Europe were of American origin.

Lieutenant R. R. Ingersoll asked about the effect of annealing on cast-steel guns.

Lieutenant Austin M. Knight referred to the very small proportion of failure in built-up guns. The effect of vibrations resulting from the explosion of gunpowder is still almost unknown.

Mr. Wm. Sellers wrote of the difficulty of securing good castings for very large guns.

Mr Charles A. Marshall said that there was much risk with large castings, while built-up guns could be tested in every part.

Mr. Henry M. Howe believed in a trial of cast guns.

Mr. A. E. Hunt spoke of the difference in quality of steel and the importance of annealing. His paper was accompanied by elaborate tables of tests made of gun steel.

Mr. John Coffin presented a summary of experiments made by Mr. J. A. Grinnell.

Professor J. W. Langley approved Mr. Metcalf's statement that steel is a fluid.

Mr. M. J. Becker referred to the increasing tendency to use cast-steel for certain parts of bridges.

Professor W. H. Burr gave some results of recent experiments. He does not believe in cast-steel for guns.

Mr. A. Gottlieb wrote of the treacherous nature of steel and the need of careful forging.

Mr. S. F. Wagner thought greater care was needed in tests; also in heating steel.

Mr. Joseph M. Wilson said that engineers could get such steel as they needed; also mentioned some results of over-annealing in eye-bars for bridges.

Mr. Percival Roberts, Jr., thought that structural steel should be tested in completed form. Chemical tests were also to be regarded.

Mr. Buck wrote of the bursting strains on guns and proposed a cast gun with an interval tube of hard steel for the bore.

After the reading of the papers there was a verbal discussion, joined in by Messrs. Worthen, Cooper, Roberts, Collingwood, Brinkerhoff and others.

Master Car-Builders' Club.

THE regular monthly meeting was held in New York, April 21, President C. E. Garey in the chair.

The subject of Lighting Cars being taken up, Mr. Dixon explained the the well-known Pintsch system of lighting by gas.

Ventilation of Cars being next in order, the Ober ventilator was shown. Mr. Creamer made a few remaks on his own and other systems.

Heating Cars was then brought up, and Mr. W. T. Taggart, of the Standard Car Heating & Ventilating Company of Pittsburgh, explained the Westinghouse heater, which is a steam heater, the boiler being suspended under the car.

Mr. Bell then spoke of the Bell Safety Casing, which is a boiler-iron box or case placed over any form of heater, and secured to the car, with provision for automatically closing the door in case of accident.

Mr. M. B. Rooney then described the Hurley System of pipes and couplings, which can be used for either steam or hot air.

Mr. Frank M. Wilder stated that he had devised a system of heating, which would soon be ready for trial.

Mr. Martin spoke of the extending use of the Martin Anti-fire System. Mr. Frost gave an exhibition of his plan for extinguishing fire in case of accident.

General Time Convention.

AT the spring meeting held in New York, April 13, this body, which has of late years extended its functions considerably beyond its original duty of arranging schedules for through trains, considered and adopted the uniform train rules, provisionally adopted at the previous meeting. A code of uniform telegraphic rules was also considered.

A report was received on the 24-hour system of reckoning time, accompanied by documents from the American Society of Civil Engineers. This subject was laid over, many of the members favoring the system, but believing that time would be required to secure its adoption.

The Committee on Uniform Car Mileage Reports presented a report giving answers obtained from a number of lines. This Committee recommended: 1. That a record should be kept of all cars switched to connecting lines, and junction reports sent daily. 2. That mileage of line cars should be reported to owning companies or line managers as companies may direct. 3. That the charge for passenger cars on foreign roads be 3 cents, postal 2 and baggage cars 1½ cents per mile. This report was approved.

Association of Railroad Superintendents.

THE half-yearly meeting was held in New York, April 12.

The Committee on Uniform Rates for Trains using other Roads in Emergencies made a report, which was discussed.

The Committee on Frogs made no report, but there was a discussion on the subject.

The Committee on Freight Car Demurrage reported, recommending a charge of $1 per day for detention, 72 hours being allowed for unloading, loading, etc. This was discussed and finally approved.

The Committee on Machinery was instructed to confer with the Master Mechanics' and the Master Car-Builders' Associations, and the Committee on Roadway with the Roadmasters' Association.

There were short discussions on Car Couplers; on Track Inspection; on Yard Signals; on Train Dispatching; on the Prevention of Fire from Locomotive Cinders; on Steam Heating of Cars; on Lighting Cars and on the use of Fire Extinguishers in case of accident.

The following officers were chosen for the ensuing year: President, H. F. Royce, Chicago, Rock Island & Pacific; First Vice-President, C. S. Gadsden, Charleston & Savannah; Second Vice-President, L. W. Palmer, New York & New England; Third Vice-President. J. B. Morford, Michigan Central; Secretary, Waterman Stone, Providence, Warren & Bristol; Assistant Secretary, C. A. Hammond, Boston, Revere Beach & Lynn; Treasurer, R. M. Sully, Richmond & Petersburg.

Standing Committees were appointed as follows: Executive, W. H. Murphy, H. Stanley Goodwin, A. B. Atwater; Machinery, R. G. Fleming, J. F. Divine, C. S. Gadsden; Roadway, Messrs. Howard, Holbrook and Law; Transportation, Messrs. Blee, Metheany and Chase.

Master Car-Builders' Association.

THE following circulars have been issued from the Secretary's office, under date of April 15:

ANNUAL CONVENTION.

The Twenty-first Annual Convention will be held in Minneapolis, Minn., beginning on Tuesday, June 14, at 10 A. M. The following is a list of the subjects on which it is expected that special reports will be made, and which will be discussed during the sessions of the Convention:

1. Standards and Appliances for the Safety of Trainmen.
2. British and Continental Practice in Matters of Interest to the Master Car-Builders' Association.
3. Automatic Freight Car Brakes.
4. The Comparative Advantages of the Two Methods of

constructing Freight Cars, with and without Platform Timbers or End Sills projecting from the End of the Car.

5. Maximum Outside Dimensions of Freight Cars.
6. Standard Draw-Gear for Non-Automatic Couplers.
7. Appliances to Prevent the Slipping of Wheels, both Passenger and Freight
8. Standard Freight-Car Truck and Axle for Cars of 60,000 bs. Capacity.
9. Standard Sizes of Lumber for Freight Cars.
10. The Best Form and Construction of Car Roofs.

The revision of the Rules Governing the Condition of, and Repairs to, Freight Cars for the Interchange of Traffic, will be the special order of business at 3 o'clock P. M. on the second day (Wednesday, June 15) of the session of the Convention. In order to take part in this revision, representatives of railroad companies must be members of the Association.

The Constitution provides that: "Any person holding the position of Superintendent of the Car Department, Master Car-Builder or Foreman of a Railroad Car Shop, or one representative from each Car Manufacturing Company, or other Company owning over 1,000 cars which are not in process of purchase by other parties, may become an Active Member by paying his dues for one year. Unless expelled from the Association, his membership shall continue until his written resigna- is received by the Secretary.

"Any person having a practical knowledge of car construction may become a Representative Member by receiving a *written* appointment from the President, General Manager or General Superintendent of any railroad company, to represent its interests in the Association; provided that no Representative Member shall represent more than one railroad or system of roads under one General Manager or General Superintendent. Such members shall have all the privileges of an Active Member, including one vote on all questions, and, in addition thereto, shall, on all measures pertaining to the adoption of standards or the expenditure of money, have one more vote for each full 1,000 cars which are owned, or which are in use and in process of purchase, by the road or system which he represents. His membership shall continue until notice is given the Association of his withdrawal or of the appointment of his successor. No railroads or system of roads, under one General Manager or General Superintendent, shall have more than one Representative Member. In the enumeration of four, six, eight or more wheeled cars, four axles to count as one car.

"SEC. 1. Every member will be subject to the payment of annual dues, to be assessed at each annual meeting, to defray the necessary expenses of the Association, provided that no assessment shall exceed $8. Each Representative Member shall pay, in addition to his own dues so assessed, the same amount for each additional vote to which he is enitled."

Blank applications for active membership and blank appointments for representative membership will be forwarded on application therefor to the Secretary. It is desirable that such applications and appointments should be filled out and forwarded to the Secretary before the annual convention is held, although persons may become members during its sessions.

Arrangements have been made with the management of the West Hotel in Minneapolis for the accommodation of the members of the Association, with board and room for $2.50 per day for each person; rooms with bath attached, $3 per day for each person. These rates are for members *only*. The Committee of Arrangements were unable to secure the same rates for those who will attend the meetings of the Association, but who are not members of it.

The manager of the hotel tenders all its accommodations to the members, but he says it will be impossible to give rooms to single persons or so large a number unless many of them will room together. A blank application for rooms is enclosed herewith. Members who wish to engage rooms are requested to fill out the names, on the enclosed card, of those persons who will room together, and then forward it to the manager of the West Hotel.

Representative members are requested to report to the Secretary, either before or at the Convention, the number of cars owned by their companies.

BEST FORM AND CONSTRUCTION OF CAR ROOFS.

YOUR Committee to report on the best form of Car Roof, at the Annual Convention to be held June, 1887, would respectfully ask your assistance in making up their report by giving them facts as you may have referring to Car Roofs, particularly as to the name, plan of construction, material and amount used, cost of labor and material average life, and any other information bearing on the subject that you may deem valuable.

They would kindly remind you that the value and importance of their report will depend largely upon your assistance in this way.

They will be pleased to receive your reply if possible not later than May 15, 1887, addressed to the Chairman, J. D. McIlwain, Grand Trunk Railway, London, Ontario.

J. D. McILWAIN.
L. PACKARD. } Committee.
S. IRVIN.

SECRETARY'S OFFICE.

Communications for the Secretary of the Association should hereafter be addressed to him at No. 45 Broadway (instead of 23 Murray street), New York.

Association of Engineering Societies.

A MEETING of the board of managers was held in Chicago, April 15, Mr. Benezette Williams presiding; J. B. Johnson acting as Secretary. The Engineering Societies of Boston, Chicago, St. Louis and St. Paul were represented.

After discussion it was ordered that the proposition submitted by Secretary Prout for the printing of the *Journal* of the Association, be accepted, provided that the number of surplus copies of each issue, over and above all takers, shall be at least 50 per cent. of the number taken in the Association, and that the remainder of these, on the termination of this contract, shall become the property of the board of managers, and provided that the publication shall appear, as heretofore, as published by this board, and provided that no article shall be allowed to appear in any periodical before the circulation of the copies of the *Journal* which contain said article.

The application of the Engineers' Club of Kansas City to become a member of the Association was granted, this making seven societies now in the Association.

Chairman Williams and Secretary Prout were unanimously reëlected to their respective offices. It was ordered that the Index Department remain under the general control of Mr. Johnson, as heretofore.

A committee appointed to prepare an address to the societies in the Association presented an address showing the advantages secured by union, and urging upon the seven societies now represented and others which may join them the formation of a National Union. It is suggested that a convention be called, to which all engineering societies be invited to send representatives.

This report was adopted, and the Chairman was authorized to send the address to all the societies, and to make arrangements for the convention when responses are received.

It was ordered that official documents of the Council of Engineering Societies upon National Public Works be published in the *Journal*. After authorizing the usual assessments, the board adjourned.

PERSONALS.

Mr. W. Crosby has been appointed Engineer in charge of the Asylum Street improvement in Hartford, Conn.

Mr. William K. Lyon has been appointed Superintendent of the Housatonic Railroad, in place of H. A. Bishop.

Mr. Harvey Sawyer is Chief Engineer of the Chesapeake & Nashville road, with office at Gallatin, Tennessee.

Mr. J. E. Capps is appointed Master Car-Builder of the Mobile & Ohio Railroad, with office at Whistler, Ala.

Mr. Reuben R. Marble has been appointed City Engineer of Columbus, O., in place of John Graham, resigned.

Mr. William Alfred Kellond is appointed Assistant to the General Manager of the Louisville & Nashville Railroad.

Mr. O. H. Dorrance has resigned his position as Superintendent of the Nebraska Division of the Union Pacific road.

Mr. E. A. Flewellen has resigned his position as Chief Engineer and General Manager of the Columbus & Western Railroad.

Messrs. Charles Kellogg and **Thomas C. Clarke** have withdrawn from the partnership known as the Union Bridge Company.

Mr. W. W. Fagan has been appointed General Superintendent of the Kansas City, Fort Scott & Gulf and the Kansas City, Springfield & Memphis roads. He has bee time Superintendent of the Central Branch, Union Pacific.

Mr. T. G. Dabney has been appointed Chief Engineer of the Memphis, Arkansas & Texas, a projected new line in Arkansas.

Mr. W. L. Richards, of Aberdeen, Dak., is Chief Engineer of the projected Aberdeen, Bismarck & Northwestern Railroad in Dakota.

Mr. Jason Rogers has been appointed a member of the Illinois Railroad and Warehouse Commission in place of W. T. Johnson.

Mr. M. J. Rogers has been appointed Master Mechanic of the Chicago, Santa Fe & California road, with office at Streator, Ill.

Mr. W. I. Allen is appointed General Superintendent of the Chicago, Kansas & Nebraska road, with headquarters at Horton, Kansas.

Mr. N. C. Ray, recently on the Union Pacific, has been appointed Resident Engineer at Butte, Mon., on the Montana Central Railroad.

General James B. Hill has been appointed Railroad Commissioner of Virginia in place of Mr. H. G. Moffet, whose term has expired.

Mr. John J. Martin has been appointed Chief Engineer of the Pine Bluff, Monroe & New Orleans Railroad, with office at Pine Bluff, Ark.

Mr. H. H. Rogers has been chosen President of the Troy Iron & Steel Company, of Troy, N. Y., in place of Chester Griswold, resigned.

Mr. Spencer Smith, of Council Bluffs, has been appointed Railroad Commissioner of Iowa in place of Judge McDill, whose term has expired.

Mr. W. B. Doddridge is appointed Superintendent of the Central Branch, Union Pacific, in place of W. W. Fagan, resigned to go to another road.

Mr. W. H. Stevenson has been appointed General Manager of the Honsatonic Railroad. He was recently on the New York, New Haven & Hartford road.

Lieutenant Commander Henry E. Nichols, U. S. N., has been ordered on duty as inspector of steel for the new cruisers, under charge of Commander Evans.

Lieutenant William B. Caperton, U. S. N., has been ordered to duty as inspector of steel at Pittsburgh, under general direction of Commander Evans.

Mr. W. D. Ballentine has been appointed Master of Machinery of the Florida Railway & Navigation Company, succeeding Mr. L. S. Randolph, resigned.

Mr. D. J. Lucas has been appointed Engineer in charge of construction of the St. Louis & Chicago road. He was recently Engineer of the East Penn Oil & Gas Company.

Mr. E. F. Fuller, of New York, is Chief Engineer of the Paducah & Illinois Bridge Company, which proposes building a bridge at Paducah, Ky., across the Ohio River.

Mr. Edward Barrington, of Washington, D. C., has been appointed Chief Engineer of the Kansas City, Superior & Northwestern Railroad, a projected line in Nebraska.

Mr. T. J. Potter, Vice-President of the Chicago, Burlington & Quincy, has resigned that office to accept the position of First Vice-President of the Union Pacific Company.

Lieutenant Colonel Peter C. Hains, U. S. Engineers, is assigned to duty in charge of the construction of the bridge over the Eastern Branch of the Potomac at Washington.

Captain Smith S. Leach, U. S. Engineers, has been assigned to duty as Secretary and Disbursing Officer of the Mississippi River Commission, with headquarters in St Louis.

Mr. T. S. Dunn, heretofore Roadmaster of the Pensacola Division of the Louisville & Nashville road, has been appointed Roadmaster of the Mobile & Montgomery Division also.

Mr. T. J. Frazier Assistant Engineer, Trans-Ohio divisions, Baltimore & Ohio, will, in addition to his other duties, take charge of maintenance of way, Chicago Division, from April 1.

Colonel R. S. Miner has been appointed Superintendent of the South & North Alabama Division of the Louisville & Nashville road in place of Mr. Levi Hege, transferred to another position.

Mr. George A. Kimball has resigned his office as City Engineer of Somerville, Mass. Mr. Kimball is in practice as consulting engineer, making a specialty of water supply and sewerage.

Mr. F. Y. Dabney has been appointed Chief Engineer and General Manager of the Columbus & Western Railroad, with office at Columbus, Ga. He succeeds Mr. E. A. Flewellen, who has resigned.

Mr. L. W. Towne has resigned his position as General Superintendent of the Kansas City, Fort Scott & Gulf and the Kansas City, Springfield & Memphis roads on account of continued ill health.

Captain W. W. Peabody has been appointed General Manager of all the Trans-Ohio lines of the Baltimore & Ohio, with office in Chicago. He was recently President of the Ohio & Mississippi.

Mr. L. S. Randolph has been appointed Master Mechanic of the Cumberland & Pennsylvania Railroad, with office at Mt. Savage, Md. He was recently with the Florida Railway & Navigation Company.

Mr. C. A. Swineford has resigned his position as Superintendent of the Madison Division of the Chicago & Northwestern road and will go to Alaska, where he intends to occupy himself in gold mining.

Mr. William G. Raoul, late President ot the Central Railroad Company of Georgia, is to be President of the Mexican National Railroad Company. Mr. Raoul is now in Mexico, inspecting the line of the road.

General John McNulta, of Bloomington, Ill., has been appointed Receiver of the Wabash lines east of the Mississippi in place of Judge T. M. Cooley, now Chairman of the Interstate Commerce Commission.

Mr. George D. Harris, for six years past Master Mechanic of the Richmond & Allegheny Road, has resigned that office and has accepted the position of Superintendent of Motive Power of the Mobile & Ohio Railroad.

Mr. Levi Hege has boen appointed General Roadmaster of the Louisville & Nashville Railroad, with office in Louisville, Ky. He has been for some time Superintendent of the South & North Alabama Division of the road.

Mr. Howard Carlton, Assistant Master Car-Builder of the Baltimore & Ohio, with headquarters at Newark, O., has resigned to accept the position of General Manager of the South Baltimore Car Works, dating from April 1.

Commodore Thomas P. McCann has been appointed commandant of the Boston Navy Yard in place of Rear Admiral Lewis P. Kimberly, relieved. Commodore McCann has been for some time on the Lighthouse Board.

Mr. Stacey B. Opdyke has been appointed Assistant Engineer of the New York, New Haven & Hartford Railroad, with office in New Haven, Conn. He was recently Superintendent of the New Haven & Northampton road.

Mr. James C. Clarke, President of the Illinois Central Railroad Company, recently tendered his resignation on account of ill health. The Directors would not accept it, and granted Mr. Clarke six months' leave of absence.

Rear Admiral Lewis P. Kimberly, (having been promoted from the rank of Commodore) has been relieved from duty as Commandant of the Boston Navy Yard and ordered to take command of the South Pacific Squadron.

Mr. William E. Rogers has been nominated by Governor Hill as Railroad Commissioner of New York, a previous nomination having been withdrawn. Mr. Rogers has just completed one term of four years ; he is a civil engineer by profession.

Mr. W. T. Small has been appointed Superintendent of Motive Power, Machinery and Rolling Stock of the Northern Pacific Railroad, with office in St. Paul, Minn., in place of G. W. Cushing, resigned. Mr. Small has been Mr. Cushing's assistant for some time past.

Mr. W. A. Scott has been appointed Superintendent of the Madison Division of the Chicago & Northwestern road in place of C. A. Swineford, resigned. Mr. Scott has been for some time Assistant Superintendent of Motive Power of the road ; he is President of the Western Railway Club.

Mr. Isaac V. Baker, Jr., has been nominated by Governor Hill as a member of the New York Railroad Commission, a previous nomination having been withdrawn. Mr. Baker has been for some time State Prison Superintendent; he was at one time with the Delaware & Hudson Canal Company.

Mr. Edward A. Moseley, of Newburyport, Mass., has been appointed Secretary of the Interstate Commerce Commission. Mr. Moseley is a member of the Boston lumber firm of Stetson, Moseley & Co., and was last year president of the Mechanics' Exchange of Boston. He is at present a member of the Massachusetts Legislature.

Mr. Reuben Wells has been offered and has accepted the position of Superintendent of the Rogers Locomotive &

Machine works at Paterson, N. J. Mr. Wells was for a number of years on the Jeffersonville, Madison & Indianapolis road, and for several years has been on the Louisville & Nashville as Superintendent of Motive Power. He has always been an active member of the Master Mechanics' Association. Mr. Wells is in every way well qualified for his new position.

Mr. George W. Cushing has resigned his position as Superintendent of Motive Power, Machinery and Rolling Stock of the Northern Pacific Railroad. Mr. Cushing has had wide experience in his department, and stands high in the estimation of his superior officers and his many friends throughout the country. In accepting his resignation, Vice-President Oakes says: "Mr. Cushing's long and successful service with this company, his ripe experience and good judgment, the present efficiency of his department, as well as other considerations, personal and official, render the necessity of accepting his resignation one of extreme regret. He will carry with him the esteem of his official associates, attended with the earnest hope that the success enjoyed here will crown his efforts in any new field he may enter.

NOTES AND NEWS.

Harrisburg Electric Railroad.—A street railroad $3\frac{1}{2}$ miles in length is to be built from Harrisburg to Steelton, Pa. It is to be an electric road on the Van Depoele system, like the line now in operation in Scranton.

Electric Railroad at Derby, Conn.—A company has been organized to build an electric railroad from Derby, Conn., to Birmingham and Ansonia. The road will be built on the Van Depoele system, and will be $3\frac{1}{2}$ miles long.

New Steel Ferry-Boats.—The Columbia Iron Works & Dry Dock Co., of Baltimore, is building two steel ferry-boats for the Staten Island Rapid Transit Company. These boats will be 236 ft. long, and will have all the latest improvements.

American Engines Abroad.—The Westinghouse Machine Company has recently received orders for two engines, 35 and 150 H. P., for a rolling mill in Moscow, Russia; two of 25 and 60 H. P., for Yokohama, Japan, and one of 150 H. P., for a mining company in Australia.

Iron Imports into Russia.—An alternative scheme for gradually abolishing the importation of iron into Russia has been submitted to the Imperial Council. It proposes either to gradually prohibit the imports of iron, or gradually increase the duties until they become prohibitory.

Geological Surveys in the Southwest.—In Arkansas and Texas laws have recently been passed providing for State geological surveys. A similar measure is urged for Missouri. In that State a survey was ordered about 40 years ago, but was never completed, and the work done was of very poor quality.

The New Naval Observatory.—Congress has made an appropriation of $100,000 for the erection of a new naval observatory near Washington. The entire cost is limited to $400,000. Mr. Hunt, of New York, has been selected by the Secretary of the Navy as architect, and is now preparing the plans.

Canals in Bengal.—There are now in the province of Bengal, India, in actual operation, 783 miles of canal. Most of these canals were built for irrigating purposes, but 553 miles are navigable, and were used last year by no less than 241,951 boats and rafts. The total area of land irrigated from the canals last year was 455,987 acres.

A Large Coasting Vessel.—The four-masted schooner *T. A. Lambert* recently sailed from Bath, Me., on her first voyage. The *Lambert* is said to be the largest vessel of her class ever built. She is 247 ft. long, 46 ft. beam and 22 ft. depth of hold; the registered tonnage is 1,620, and the carrying capacity 2,700 tons of coal. The vessel will carry coal from Baltimore to Boston.

Abandoning a Canal.—The Philadelphia & Reading Railroad Company, which leases and works the Schuylkill Canal, has decided to abandon the use of the canal altogether, claiming that coal can be carried more cheaply by rail. The bondholders of the canal will, however, foreclose their mortgage, and announce that they will keep the canal open after they secure control.

Allen Paper Car Wheel Company.—On April 1 the general offices of this company were removed from New York to Chicago. The company retains a branch office in New York, which is, from May 1, at Nos. 31 and 33 Broadway, and is in charge of the Vice-President, Mr. J. C. Beach. This New York office will also be the headquarters of Mr. L. F. Tracy, Eastern agent of the company.

Scranton Electric Railroad.—The Scranton Suburban street railroad, which is an electric road built by the Van Depoele Electric Manufacturing Company, was opened November 1 last. Under the contract, it was operated by the builders until April 1. At that time, its working having proved satisfactory in all respects, it was formally accepted by the company. It is proposed to build an extension of the line.

Belgian Iron and Steel Production.—The pig iron made in Belgium in 1886 was 697,110 tons, a slight decrease from 1885. The total output of manufactured iron last year was 470,022 tons. The steel made was: Cast-steel (ingots, etc.), 139,215; forged steel (rails, plates, etc.), 129,418; total, 268,633 tons.

The coal mined in Belgium last year was 17,253,144 tons.

The Naval Ordnance Shops.—Plans for the ordnance shops at the Washington Navy Yard have been prepared by the board of officers and submitted to the Secretary of the Navy.

By these plans the shops will, in a short time, be ready to handle guns up to 6-in. bore, but it will require two years to procure the necessary plant for handling and fitting very large guns.

Union Bridge Company.—The partnership heretofore existing under the title of the Union Bridge Company expired by limitation on March 1, last. At the same time a new partnership, under the old name, was formed by C. S. Maurice, George S. Field, Charles Macdonald and Edmund Hayes. These gentlemen were all in the old firm. Messrs. Charles Kellogg and Thomas C. Clarke, of the old firm, do not join in the new one.

Car Heating and Lighting.—The Boston & Albany Company now has a train running on the New York–Boston through line which is heated by steam from the locomotive, the Martin anti-fire heating system being used. This train is lighted by electricity, the Julien storage battery system being used.

The Fitchburg Railroad Company has equipped a train with the Sewall system of heating by steam from the locomotive. This train is now in regular service.

Russian Locomotive Works.—The Russian Government has sanctioned an increase to the capital of the Kolomna Locomotive Works of $750,000, to be expended in adding to the plant and developing the resources of the establishment. It was recently stated that large orders for locomotives had been given to the works for locomotives for the South and Southeast Russian railways. The head of the establishment is General Struve, the eminent shipbuilder.

Car Lamp Patent Suit Ended.—The patent suit brought a number of years ago by Messrs. Hicks & Smith against the Chicago, Milwaukee & St. Paul Railroad Company, the Dayton Manufacturing Company and others for alleged infringement of the Hicks & Smith patents on car lamps, has finally been dismissed. A satisfactory settlement of the controversy has been agreed upon and a license has been given to the Dayton Manufacturing Company to use the Hicks & Smith patents.

Proposed Mining Tunnel.—It is proposed to build a mining tunnel or adit to drain the gold mines at Nevada City and Grass Valley, Cal., which yield a steady amount of moderately rich ore, but have now reached a depth at which the cost of pumping is heavy. The tunnel will be about 12 miles long and will enter the mines at from 1,200 to 1,300 ft. below the surface. In building the tunnel, it is proposed to use compressed air, the compressors to be worked by the water power of the Yuba River.

Block Signals on the Erie.—The Union Switch & Signal Company has taken a contract to equip the Eastern Division of the New York, Lake Erie & Western road with a system of block signals and interlocking switches. The system will extend from Jersey City to Turners, miles, and in that distance there will be 27 towers or signal stations and 10 points at which there will be a complete system of interlocking switches. The work will cost about $60,000, and will be finished in June.

"Gabarets."—The *National Car-Builder* says: "The Pittsburgh, Cincinnati & St. Louis Railroad is noted for the convenience and ingenuity of its 'gabarets.' Superintendent of Motive Power Wall invented the name and helped Engineer Harrington to design the article. It is used for measuring the height and breadth of cars and their loads. When Mr. Harrington first received orders to make a drawing of a gabaret, he thought the thing was connected in some way with jaw, and he was not very far out."

Locomotive for Suburban Service.—The Rhode Island Locomotive Works in Providence recently delivered to the

Boston & Providence road a locomotive of the Forney pattern, intended for service on the suburban trains out of Boston. The engine has 17×24 in. cylinders and four drivers 56½ in. diameter. The boiler is 48 in. diameter of barrel and has 156 tubes 10 ft. 6½ in. long. The weight is 112,400 lbs., of which 63,700 lbs. are on the drivers, and 40,700 lbs. on the truck. The truck, under the tank, has six Krupp steel wheels.

Pennsylvania Railroad Improvements.—The Pennsylvania Railroad Company is making many improvements at Harrisburg, Pa. The main line is to be changed to the old canal bed, thus avoiding a number of street crossings. The freight yard is to be enlarged so that freight trains will not have to use the passenger tracks. The foundations have been laid for a new passenger station.

The length of sidings at many points between Harrisburg and Altoona is to be increased and some new sidings built.

Blast Furnace for Cuban Ore.—The Pennsylvania Steel Company has bought a tract of 600 acres of land at Sparrow's Point, nine miles from Baltimore. This tract has a fine water front and will be connected with the Northern Central Railroad by spur tracks. At this place the Company will build two blast furnaces for the purpose of making pig-iron from the ores brought from the mines at Juragua, Cuba, which are owned jointly by this company and the Bethlehem Iron Company. The ore will be delivered from vessels, and the pig-iron will be shipped directly to Steelton by rail.

Sandberg's Goliath Rails.—The *Journal de Liége* mentions that recently Messrs. Cockerill commenced to roll Mr. Sandberg's "Goliath" steel rails of 50 kilos. per meter, or 100 lbs. per yard, for the Belgian State Railways. The rails are rolled from ingots weighing nearly a ton, making two rails of nearly 30 ft. in length. The fastenings and joints proposed by M. Flamache are being made at the same train of rolls. Tests are being made to prove the strength of the rails, some of which are to be put down at once on the trunk lines between Liége and Verviers, and the Plateaux de Herve line.

A New Steam Engine.—Herr Wilhelm Schmidt, of Braunschweig, is the inventor of a new type of steam engine, working with very high steam pressure. The steam, before being admitted to the cylinder, is reduced in pressure and increased in volume by means of an injector where the steam from the boiler mixes with a portion of the exhaust steam. An experimental engine of some 40 H. P. has been at work for some time, with satisfactory results, and a marine engine on this principle is now being built by Messrs. Blohm & Voss, in Hamburg, who have the exclusive licence for this system as applied to marine engines.

Electric Train Signals.—The Judkins electric train signal, which is in use on several New England roads, has heretofore derived its power from a battery carried on the train. A new plan is to be used hereafter, a compact little dynamo run by a small engine, which takes steam from the locomotive boiler. The arrangement is so very compact that the engine and dynamo together take up a space only 8 in. long, 6 in. wide, and 10 in. high. It is to be placed in the cab. As only 10 lbs. pressure is required to run the engine, the amount of steam required will be very small. Trains on the Old Colony Railroad are to be equipped with this device.

Iron Making in New England.—The Gosnold Mills, at New Bedford, Mass., have closed down permanently. They have been in operation since 1856 in the manufacture of rolled iron, chains and small cut nails. The Boston *Herald* says that "the directors have made up their minds that it is of no use for New England, where the fuel to work a ton of iron costs $4, to attempt to compete with districts where natural gas costs only 60 cents in the manufacture of staple iron goods. The machinery will probably be disposed of where it can be used to advantage, and the buildings, which are not adapted to any other purpose, will be taken down."

New Vessels for the Navy.—The Secretary of the Navy has advertised for proposals for building five new vessels for the Navy. They are the *Newark*, the appropriation for which was increased by the act of March 3, '87, from $1,100,000 to $1,300,000, the two 4,000-ton crisers to have a speed of 19 knots, and the two gunboats of the type of gunboat No. 1, authorized by the same act. The plans and specifications for the *Newark* are about complete. Those for the two gunboats are nearly ready, but those for the two cruisers are in a less advanced condition. The advertisement states that they will be ready by June 1.

Transparency of Molten Iron.—Mr. Wm. Ramsay writes to the London *Chemical News* as follows: "Some days ago I was present when a casting was made involving the pouring of several tons of molten cast-iron. The stream was very regular, and resembled a great waterfall. It was possible to see objects through the molten metal, which appeared to be of a yellowish color, but tolerably transparent. Two gentlemen who were present were also convinced of the transparency of the metal. May I ask, through your columns, the opinion of those who have frequent opportunities of being present during the operation of casting, regarding this seeming transparency."

Wear of Rails in India.—*Indian Engineering* says: "We are informed that the 42-lbs. steel rail on the South Indian meter-gauge line are so badly worn as to need very extensive renewals, and are to be replaced by rails of 50 lbs. The 42-lbs. rails are only 10 years old. On the other hand, there has been practically no wear in the 75-lbs. steel rails used on the Madras broad-gauge line, although some of them are 15 and 20 years old. In connection with this subject we may observe that *speed* must be an element in the wear of rails when it exceeds say 15 miles an hour; but it is a mistake to suppose that a line with steep gradients can be worked as economically in this respect as a level one."

Wooden Outlet Sewer.—Mr. Horace Loomis, Engineer of Sewers, New York City, is now building at Pier 29, East River, an outlet sewer of creosoted yellow pine. The sewer is circular, 4 ft. in diameter and 541 ft. long. The staves are 4 inches thick, placed radially, and are secured by galvanized iron hoops 3 × ⅜ in., tightened by two bolts passing through shoulders on the semi-hoops. The hoops are spaced about 4 ft. apart, and the sections of the sewer butt squarely, the joint being covered by an 8 × ⅜ in. hoop. This sewer is supported upon caps bolted to the piles of the wharf previously in place, the joints of abutting sections being made to rest upon these caps.—*Engineering News.*

A New Fuel.—Mr. Sahlstrom, of the Normal Company, Aberdeen (Scotland), has, after a long series of experiments, discovered a new fuel, which is said to be an efficient and economical substitute for coal, as regards steam boiler furnaces. The basis of the new fuel is pitch oil, which is used in combination with superheated steam. The invention has been in practical use at the Normal Company's works for some time, and although the boiler furnace was not specially constructed for the new fuel, satisfactory results have been obtained, a saving of nearly 30 per cent. in the cost of fuel having been effected. We purpose giving in an early issue further details of this fuel, and the method of working adopted.

South American Geography.—The French Hydrographical office has published a map of the Cape Horn Archipelags and the Beagle Channel, from the surveys made by the steamer *La Romanche* during the years 1882 and 1883, when a polar station, according to the international plan, was established in Orange Bay. The map contains many important corrections of the coast line.

The Instituto Geographico Argentino has issued the first sheets of the *Atlas de la Republica Argentina*, edited by Dr. A. Seelstrang. The basis of the atlas and the surveys of the land office, the railroads and the boundary commissions. It will consist of 30 sheets, each province being represented on a scale of 1 : 1,000,000.—*Science.*

Photographing the Sky.—*Science* says: "Ensign Winterhalter, of the U. S. Naval Observatory, has sailed for Paris to represent the Observatory at the conference called by Admiral Mouchez, Director of the Paris Observatory, for the purpose of forming a plan of co-operation in photographing the whole sky. The proposition is to enlist 10 or 12 observatories in the undertaking, and to obtain instruments of uniform power, so that their work may be homogeneous. If the suggestion that each plate shall be four degrees square be adopted, about 11,000 plates will be required; and, with an average of 100 plates per year from 11 observatories, it will take 10 years to complete the map. It is understood that Dr. Peters, of Clinton, N. Y., and Mr. Rutherford, of New York, will also attend the conference."

Baltimore & Ohio Technical School.—The success of the plan for giving technical instruction to the apprentices of the Mt. Clare shops of the Baltimore & Ohio Railroad has been so encouraging, that the directors of the company, at a recent meeting, authorized the establishment of a permanent technical school in connection with the Mt. Clare works. The organization of this school is to be such "as will, on a permanent and well-considered plan afford those entering its service a liberal education in mechanics, engineering, drawing, chemistry and the applied sciences, and give the service the benefit of scientific research and invention as applied to railroad matters."

For the support of the school the directors voted $25,000 for the current year, and fixed $20,000 yearly as the regular appropriation hereafter.

Sugar for Boiler Incrustations.—According to M. Polto, the weekly addition of about 4½ lbs. of sugar to the feed water of a tubular boiler with 126 tubes prevented the formation of incrustations and even detached old deposits from the tubes, when, before the sugar was used, the boiler had to be cleaned out after 45 days of work. The *Chemiker Zeitung*, which publishes this statement, says, however, that it should be noted that sugar, at a temperature corresponding to a pressure of four or five atmospheres, gives place rapidly to the formation of acids, especially formic acid, and that these acids will corrode the boiler shell rapidly. It will therefore be necessary to be careful in the introduction of sugar for the purpose of preventing incrustation, and to make further investigations before admitting its value for this purpose.

An Old Forge.—The *Bulletin* of the American Iron and Steel Association says: "Martic Forge, on Pequea Creek, near the village of Colemanville, in Lancaster County, Pa., has at last been abandoned. Mr. Robert S. Potts, surviving partner of the firm of Davies & Potts, which owned the forge for many years, died in June, 1886, at a good old age, and the forge has since been idle. The property is for sale, but there is no expectation that iron will ever again be made at Martic with a tilt-hammer. The forge is one of the oldest in the country, having been built in 1755. Negro slaves were employed from the beginning in hammering iron at this forge, and it is a curious fact that negroes continued to be the principal workmen down to its abandonment last year. A long row of stone houses is still occupied by them."

Car Heating by Steam.—A trip was recently made over the Maine Central Railroad with a train of 12 cars heated on the Sewall plan. This is the longest train yet tried on that system, and the trip was very successful. Although the day was cold and windy, the cars were kept at 70° to 80,° and no difficulty was found with the engine.

The Pennsylvania Railroad Company has been for some time trying a system of steam heating on a local train on the New York Division. The results have been so good that, it is stated, the use of this system will be extended.

All the trains on the Providence, Warren & Bristol road are to be equipped with the Gold system of steam heating. Mr. Waterman Stone, Superintendant of the road, had one train equipped with the Gold system some time ago, and has found its operation very satisfactory.

Accidents to Employes in Massachusetts.—The Massachusetts Commission report for 1886, says, of the accidents on the railroads of the State: "Of the 274 casualties to employés, 63 were fatal and 211 not fatal; 213 were trainmen and 61 were employed in other capacities. By coupling or uncoupling cars, 2 were killed and 105 were injured. Only one accident is reported as occurring where an automatic coupler was used. In that case a damaged United States coupler connected with an ordinary link and-pin drawbar. Two trainmen were killed and 6 were injured by overhead bridges. Train accidents killed 8 and injured 18. The most fatal class of accidents to trainmen is falling from trains in motion, 17 persons having been killed and 38 injured in this way, most of them severely. By various other accidents 34 were fatally, and 44 not fatally, injured."

Railroad Accidents in Connecticut.—The report of the Connecticut Railroad Commissioner for 1886 gives the number of persons killed and injured during the year on the railroads of the State as follows:

	Killed.	Injured.
Passengers	5	37
Employés	25	142
At highway crossings	9	5
Trespassers	55	47
Total	94	231

Of the 167 employés killed or hurt 60 received their injuries in coupling cars, 27 by falling from trains, and the remaining 80 were hurt in various other ways.

Nearly all of the persons classed as trespassers were killed or injured while walking on the tracks.

Iron Ore in the Bottom of a Lake.—Something new in the way of exploration has been tried during the past winter at the Cleveland mine, at Ishpeming, Mich. The extreme cold formed 2½ feet of ice on the surface of Lake Angeline, when a diamond drill was taken out upon it and several holes bored in the bottom of the lake, which resulted in finding an extension of the Lake Superior hematite running along on its north shore. The lake is surrounded on all sides but the west by high precipitous bluffs of diorite and mixed ores. Along its south shore is the Lake Angeline Mine; very near the northwest end is the Superior Hematite Mine, and the basin of the lake was always supposed to contain large quantities of iron ore. The drill holes now put down show that supposition to be correct. Probably no one ever before took a diamond drill on the ice to explore the bottom of a lake.

Bridges in Indian.—*Indian Engineering* says: "This year will be marked by engineers in India as the 'great bridge year.' Of the many important bridges now under construction and approaching completion the following are noteworthy as showing the magnitude of such work in India: a bridge over the Sutlej, on the Ferozepore Railroad, with 27 spans of 150 ft. each; one over the Jumna at Kalpee, on the Indian Midland Railroad, with 10 spans of 200 ft. each; one over the Jhelum, on the Sind-Sarya Railroad, with 17 spans of 250 ft. each; one over the Gunduck, to connect the Tirhoot system with the Bengal & Northwestern Railroad, with 8 spans of 250 ft. each; one over the Ganges at Benares, on the Oudh-Rohilkund Railroad, with 7 spans of 356 ft. and 9 spans of 115 ft. each; and another over the same river at Balawala, with 11 spans of 256 ft. each; another is that over the Indus at Sukkur now waiting the arrival of the iron-work for a span of 790 ft."

Baltimore & Ohio Employes' Relief Association.—Payments in this Association for February were:

	Number.	Amount.
Accidental deaths	11	$11,500
Accidental injuries	271	3,512
Natural deaths	8	4,300
Natural sickness	471	7,008
Physicians' bills	265	1,233
Total	1 026	$27,553

The total payments from May 1, 1880, to February 28, 1887, were $1,332,748.

The following elections are announced: Members of Committee of Management, A. J. Cromwell, Arthur Sinsel, E. L. Weisgerber, F. H. Britton, Thomas Griffin. Trustees Savings Fund and Building Feature, Thomàs Fitzgerald, E. L. Weisgerber.

A Convict Dynamo.—The *Electrical World* says: "The utilization of prison labor as a motive force in connection with the electric light has been much talked about of late, in England, and it is generally admitted by political economists there that criminals might be better employed than in grinding the wind. A great deal of power which could be turned to excellent account is undoubtedly wasted, and the use of the crank as a mere punishment in many London jails has often been condemned. The main objection to prison labor as a motive force seems to be that it is intermittent in character. But, then, it is urged that relays of prisoners might be arranged for and a continuous supply of force secured. There are three shifts in 24 hours in many collieries, and always two; there are three watches on board ship, and the advocates of the system contend that some such plan might be brought into operation with a view to secure a continuous motive power for the production of electricity and many other purposes."

Crossing Accidents in Massachusetts.—The Massachusetts Commission report for 1886 says: "At grade crossings, with gates or flagmen for the protection of travellers on the highway, there were 15 casualties, and at crossings without gates or flagmen, 20. Twenty-two persons were killed and 13 were injured. The greatest number of casualties of this class on any one road occurred at crossings having gates or flagmen, but the most serious accident happened about 9 o'clock in the evening at a crossing where the gate-tender had left his post, according to his usual practice, at 8 o'clock, and the crossing was unguarded. The number of these accidents is more than 20 per cent. less than last year.

"The number of trespassers killed and injured was 7 more than last year, 130 of whom were injured when walking or lying on the track, and 29 when stealing or attempting to steal a ride on freight cars. The number killed was 91, being two less than last year. The number of this class of victims of their own folly varies less from year to year than other casualties."

New Bridges.—After considerable litigation and trouble, the Utica, Clinton & Binghamton Company has secured the right to construct a bridge across the tracks of the New York Central and the Delaware, Lackawanna & Western at Utica, N. Y., to connect its road with the Utica & Black River directly without transfer. This work will consist of 1,000 ft. of embankment, 4 lattice bridge-spans of 100 ft. each, 150 ft. of timber trestle, and six large piers and abutments, and 30 pedestals of masonry to support 350 ft. of iron viaduct. The masonry for this work will be constructed by J. J. Campbell, of Lowville, N. Y., and the Rochester Bridge Works will construct the iron work.

A new iron lattice bridge 150 ft. span, with provisions for

second track, has just been completed on the Troy & Boston at Pownal, Vt., by the Rochester Bridge Works, under the superintendence of Prof. P. C. Ricketts, of the Rensselaer Polytechnic Institute. This is the second large iron bridge built by the Troy & Boston during the past year.

Spanish Iron Ore.—The London *Engineering* says: "The exports of iron ore from Bilbao last year amounted to 3,160,047 tons, as compared with 3,295,982 tons in 1885, and 3,155,432 tons in 1884. In these totals the shipments to Great Britain figured for 2,151,137 tons in 1886; 2,050,185 tons in 1885; and 1,990,993 tons in 1884. The Low Countries took 534,687 tons in 1886, as compared with 653,919 tons in 1885; and 601,414 tons in 1884, while France took 332,103 tons in 1886, as compared with 491,085 tons in 1885, and 458,225 tons in 1884. It is noticeable that a commencement has been made with deliveries to the United States, 42,337 tons having been forwarded to the great transatlantic republic in 1886, as compared with 7,304 tons in 1885, and 2,259 tons in 1884. It will be observed that the shipments to Great Britain are increasing rather than otherwise, and that they amounted in 1886 to 68.04 per cent. of the whole exports of the year. The proportion of the exports to Holland last year was 16.60 per cent., and that of those to France, 10.52 per cent., leaving only 4.84 per cent. to represent the shipments in all other directions."

A New Torpedo Boat.—For some time past the various naval aurthorities, both English and foreign, have been looking forward with interest to the completion and trial of a couple of torpedo boats that Messrs. Yarrow and Co. have been constructing for the Italian Government. These craft are 140 ft. long on the water-line, by 14 ft. beam, and are fitted with twin screws. They have two loco-marine boilers of the usual torpedo-boat type made by this firm. These are placed one forward and one aft of the engine-room. The arrangement is such that the boilers and engines can be worked independently of each other, or either boiler can supply either or both engines with steam; so that as long as one boiler and one engine, no matter which, remained uninjured, the vessel can be manœuvred. The first of these boats was recently launched, and made her official trial last week. The following is the mean of six runs on the measured mile: Steam pressure, 130 lbs; vacuum, 26½ lbs.; revolutions, 372; speed, 24.96 miles. The lowest speed of the six runs was 22.36; the highest, 22.69. The displacement was about 100 tons, and the indicated H. P. is said to have exceeded 1,600.—*Engineering.*

English and American Iron Production.—*Iron* says: "While last year we in this country have had to be contented with very modest morsels of comfort, our cousins across the Atlantic have been enjoying extremely prosperous times. The production of pig-iron in America, which was 3,200,000 tons less than of Great Britain in 1885, came within 1,200,000 tons of it last year, 2,000,000 tons having therefore been wiped off in the one year; for while our production decreased by 379,992 tons, that of the United States increased by 1,640,017 tons. But if one derives consolation from the misfortunes of friends, it is reassuring to know that this country was not in such a bad plight as Germany, where the output of pig-iron declined last year by 411,972 tons. Although we still maintain our lead so far as pig-iron is concerned, the United States outstrips us in respect of steel. The production there of Bessemer steel last year amounted to 2,269,000 tons, against 1,570,000 tons in this country; but our superior production of open-hearth steel somewhat reduced the gap between the two, making the total production of steel in the United Kingdom 2,264,000 tons, against a total in America of 2,488.000 tons."

A New Zealand Dredge.—A dredge, built by Messrs. Kincaid, M'Queen & Co., Dunedin, for the Bluff Harbor Board, was recently launched, and named the *Alpha*. The material used in the construction of the *Alpha* was, of course, imported. She is built entirely of mild steel, and her dimensions are: Length 50 ft., over all; breadth of beam, 15 ft.; depth of hold, 6 ft. 6 in, She is capable of raising 75 tons of spoil per hour at a depth of 18 ft., and will, therefore, be peculiarly applicable for dredging purposes in such a river as she is intended to work in, its bottom being shingly and shifty. Her engines, which are also constructed by Messrs. Kincaid, M'Queen Co., are high-pressure, of 70 H. P., the diameter of the cylinder being 8½ in., and the length of stroke 12½ in. The *Alpha* is fitted with an multitubular steel boiler 15 ft. 6 in. long, and 4 ft. 8 in. in diameter, with 38 tubes. each 3 ft. in diameter. Her boilers stand a working pressure of 80 lbs. to the square inch, and have been tested and certified to a pressure of 160 lbs. to the square inch. She has a screw propeller, and is fitted with a rudder on each quarter in order that she may be the more easily handled. Her decks are planked with kauri pine.

Induction Telegraph for Trains.—The Railway Telegraph & Telephone Company, owning the patents of Wm. Wiley Smith, Thos. A. Edison and W. T. Gilliand, and the Phelps Induction Telegraph Company, owning the patents of L. J. Phelps, both of New York, have consolidated and formed a new company under the name of the Consolidated Railway Telegraph Company, with office at 13 Park Row, New York. The new company now possesses all the patents covering telegraphing by induction-telegraph to and from moving trains. This company assumes the contract of the Phelps Company with the Lehigh Valley Railroad, and is now operating the same on the New Jersey Division (50 miles) upon three trains a day each way. It also, within a short time, will begin to place this system on the main line of the New York, New Haven & Hartford Railroad, under an existing contract. Negotiations are also being carried on toward placing this system on several trunk lines. The officers of the new Company are: President, Chas. A. Cheever; Vice-President, Chas. E. Crowell; Secretary and Treasurer, Henry D. Hall; Electrician and Superintendent, Lucius J. Phelps; Consulting Electrician, Thos. A. Edison.

Cement.—The use of blast furnace slag in the manufacture of cement, it is said by a correspondent of *Industries*, is rapidly increasing in Germany, and the employment of slag cement is permitted in works carried on for or under the supervision of Government. The slag, when issuing red hot from the furnace, is dropped into water, and thus broken up into pieces the size of peas. The granular mass is then ground and mixed with lime and silicate of alumina in certain proportions, and then sifted and again ground. The cement thus produced is very cheap, and has excellent hydraulic qualities; large quantities are exported to Sydney, Valparaiso, Rio, and much of it is also used at home. Comparative tests made with this cement and Portland cement manufactured by the Oppeln Works, one of the best manufacturers in Germany, have shown that the tensile strength of the latter is 318 lbs. per square inch, and whilst slag cement gave 380 lbs. per square inch, one variety, which was used in the construction of a public building in Berlin, showed as much as 392 lbs. tensile strength per square inch. In Government contracts, slag cement is admitted not only for mortar, but also for concrete walls.

A Buoy Ship.—Barclay, Curle & Co., at Whiteinch, Scotland, recently launched the *Samson*, a buoy vessel of a most unusual character. Built to the order of the Port Commissioners of Rangoon, and intended for laying and recovering buoys, moorings, lost anchors, and chains, etc., over the district to which the jurisdiction of that body extends, the vessel measures 115 ft. by 23 ft. by 12 ft. 4 in., and her register is 205 tons. She is strongly built, and her machinery is likewise of great strength. The fittings include an enormously heavy machine, which is capable of lifting the heaviest moorings; very heavy chain cables; steam windlass to heave out on the one side and heave in on the opposite side at the same time; two powerful steam capstans, one of them able to raise 40 tons; heavy bow and stern davits; and an appliance for carrying to sea buoys of the largest class. She has also a peculiarly formed bowsprit, adapted for raising and lowering heavy weights. A boiler has been fitted on board, with capacity to supply steam to work all the machinery simultaneously. All the chain pipes throughout the vessel are of steel. The vessel is rigged as a brigantine and will proceed to her destination under sail.

New York Railroad Bridges.—It will be remembered that, in 1884, the New York Railroad Commission sent out a circular to the railroad companies of the State, asking for drawings and strain sheets of all the bridges on their lines. To collect the information required took some time, as in many cases the companies did not have the information required, and had to go back to the builders. In course of time, however, a great mass of data was received. These materials were placed by the Commission in charge of Mr. Charles F. Stowe, a competent engineer, and from them he has compiled an elaborate report which will shortly be issued, and which will be a valuable document.

The object of this investigation was to prepare the way for the establishment of a standard below which railroad bridges should not be allowed to fall. The Commission recognized the fact that the strength of bridges had not kept pace with the increased weight of rolling stock, and that the security of passengers and employés required some action. As a standard for those of the 3,500 bridges in the State, where maximum loads were not reported, the report assumed 80,000 lbs. as the weight of a locomotive on standard-gauge roads, with four driving wheels and a 14.75 ft. wheel base. The running lead

behind the tender is calculated at 2,240 lbs. to the foot of track, the Board allowing, on iron members of bridges, a 10,000 lb. maximum stress, and for wood 800 lbs. in tension.

The Canadian Geological Survey.—The proposed field-work of the Canadian Geological Survey for the coming season includes an extensive topographical and geological survey of the upper Yukon, of which Mr. Dawson will be in charge. It is proposed that one branch of the expedition shall proceed through the valley of the Stakeen River, cross the summit of the Rocky Mountains, and ascend the Liard River. Here they will pass the water-shed between the Yukon and the Mackenzie and descend the Pelly River. At Fort Selkirk, where the Pelly joins the Yukon, they will meet the other branch of the expedition, which will proceed from Chitlkat Inlet (Lynn Fiord) to the headwaters of the Yukon. From Fort Selkirk, short expeditions will be made up the branches of the Yukon on both sides, and also down the main stream. Mr. W. Ogilvy, who will be in charge of this branch of the expedition, will remain in the district during the winter of 1887, but Dr. Dawson will return next fall by the route of Lynn Fiord.

It must be regretted that a survey of the boundary between Canada and the possessions of the United States cannot be undertaken at the same time, as both expeditions would help and further one another.—*Science.*

Railroad Bridges in Connecticut.—The report of the Connecticut Railroad Commissioner for 1886 says: "Ten years ago the aggregate length of wooden bridges and trestles on the railroads in this State was 97,780 ft., or 18.52 miles, with 9,108 ft., or 1.72 miles of iron, and 3,708 ft., or 0.702 mile of stone arches. On the same roads there are now only 72,747 ft., or 13.12 miles of wood, and 3,732 ft., or 0.707 mile of stone arches, while there are 18,061 ft., or 3.42 miles, of iron bridges. This shows a total reduction of 6,356 ft., or 1.20 miles, in the length of all kinds of bridges by reason of earth filling, and the reduction of 25,333 ft., or 4.80 miles, in the length of wooden bridges and trestles by the substitution of iron and stone, and by filling. During the same time there has been added, by the building of new roads and extensions, 5,476 ft., or 1.03 miles, of wooden bridges, 874 ft. of iron, and 212 ft. of stone."

This makes the total length in lineal feet of railroad bridges in the State:

	Miles.	Per cent.
Wood	14.758	77.3
Iron	3.586	18.8
Stone	0.747	3.9
Total	19.091	100.0

The proportion of wooden bridges seems somewhat large. With a few exceptions, the bridges are short, the State having many small streams and watercourses.

Telegraphs of the World.—At a recent conference at Salzbourg, Herr Hafner, an officer of the Austrian department of posts and telegraphs, presented the following notes on the extent of the telegraphic lines of the world.

The length of aerial or pole lines, in round numbers, Herr Hafner gives as follows, in kilometers:

	Lines.	Wires.
Europe	500,000	1,000,000
America	200,000	400,000
Asia	50,000	70,000
Africa	30,000	40,000
Australia	20,000	30,000
Total	800,000	1,540,000

Underground lines have so far come into use only in France and Germany, outside of city lines. Each of these countries has about 37,000 kilometres of underground lines.

The building of 800,000 kilometers of aerial lines must have required some 14,000,000 poles, and the wires weigh about 240,000 tons.

The average price of aerial lines may be put at about 1,000 francs per kilometer (or $320 per mile), while underground lines cost five or six times as much.

There are now 12 submarine cable lines between Europe and America, the longest being the French line from Brest to St. Pierre Miquelon, which is 4,905 kilometers long. Besides these, the five great divisions of the world are now all united by submarine lines.

Steamboats in Siberia.—At a recent meeting of the Russian Mercantile Marine Society, M. Igoumnoff read an interesting paper on the present condition of shipping on the Siberian rivers. The first steamer in Siberia made its appearance in 1842, but it was not until 1845 that one of any size began to run; the pioneer vessel being the *Osnova* or *Basis*, having machinery of 60 H. P. In 1854 the total number of steamers in Siberia was 5, in 1860 there were 10, in 1865 the number had increased to 23, in 1876 to 43, and by the end of last autumn to 58. This is not a large number for a territory larger than all Europe or Canada, and which Russia has held for 300 years. Besides steamers there are 200 barges, ranging in length from 200 ft. and 250 ft., and 100 from 150 ft. to 200 ft. long. The most powerful steamer on the Siberian rivers is one of 160 H. P. The center of the traffic is Tiumin, through which goods to the extent of 4½ million poods, or 70,000 tons, pass every year. It is the drawback of the Siberian rivers that they nearly all flow to the Arctic region, and although some years ago English navigators penetrated to the Obi and Yenesei, the perils of the passage through the Kara Sea nipped the enterprise in the bud. At present there is little inclination to increase the steamers in Siberia, as its raw produce cannot find a ready market in Russia, owing to the competition in the corn, hide and tallow trade. About 8,000 peasants migrate thither every year, and the extension of the railroad system is opening up the country, but none the less its progress is very slow.

Harrisburg Bridge.—The Cumberland Valley Railroad Company is rebuilding its bridge over the Susquehanna at Harrisburg, Pa. The first bridge erected by the company at this point was finished January 16, 1839. It was a lattice bridge, 4,228 ft. in length, the deck of which was used for railroad purposes, the cars being hauled across by horses. Below the deck were two roadways for ordinary wagon travel.

This bridge was destroyed by fire December 4, 1844. On February 3, 1845, a contract was made with Mr. Eleasor Kirkbride, for the erection of a new bridge. Owing to various misfortunes, this bridge was not completed for a couple of years. In 1850 it was strengthened for railroad purposes, and its use discontinued as a wagon bridge. In 1856 it was substantially rebuilt as a Howe truss. The lower chords were renewed in 1871 at a cost of $72,520. In 1878, it became necessary to give additional strength to the structure, and arches were put in as auxiliary to the truss at an expense of $33,105. All the piers have been rebuilt in a most substantial manner at an entire cost of $113,359.

In September last, contracts were made with the Union Bridge Company, of New York, and the Edge Moor Iron Company, of Wilmington, Del., to replace the present wooden bridge with an iron one; the Union Bridge Company contracting for the western half, and the Edge Moor for the eastern half. The cost of this work, will be about $225,800. The Union Bridge Company has just completed its half of the bridge, and work is in progress on the other half.

Not a Promising Field for Young Engineers.—The *Indian Engineering* says: "The Bombay Public Works Department have for years been far behind all other provinces and lists in point of promotion. But 1886 has changed matters somewhat for the better, for they have had no less than six steps, five by retirement and one by death, of highly graded officers: Colonel J. M. Creig and Colonel J. R. Maunsell, Superintending Engineers; Colonel B. H. Matthew and Major M. T. Macartney, Executive Engineers, first grade; Mr. W. Clarke, Executive Engineer, second grade, all retired—and Colonel E. P. Gambier, deceased. During the current year there will, it is thought, be three retirements—those of General Goodfellow, Colonel John LeMesurier, and Mr. F. D. Campbell, Chief, Superintending and First Grade Executive Engineer, respectively. To judge how bad things were last June, before this small run of promotion came in, the following figures show the length of service of the *senior* in each grade: Executive Engineer, first grade, 28 years; second grade, 24 years; third grade, 19 years; fourth grade, 15 years; Assistant Engineer, first grade, 13 years.

"One step—that of Colonel Maunsell—still remains to be filled, but the *present* seniors of the above grades are of 28, 20, 19, 11, and 10 years' service respectively. It is something approaching to almost a scandal that an officer of 20 years' good service, who is talented, bears a blameless reputation, and has a high University degree, should still be in the second grade of Executive Engineers. Such is Bombay luck!

New Railroads in Norway.—Although no definite decision has been, or is perhaps for some little time likely to be arrived at, as to the prejected railway from Bergen to Christiania, the time is not far distant, when the two largest towns in Norway will be connected by a railroad line. Whatever route may be adopted, and there are several on the tapis, this new line will offer very considerable engineering difficulties, and it is only within the last few years that the scheme has been looked upon as at all practicable. The latest plan—the Aurland line—is said to possess several advantages over its predecessors, but still it will, for a distance of 20 kilometers, have to run at a height of 3,000 ft. above the sea level. Its highest point—Gjeitserryggen—is about 1,130 meters, or some

3,600 ft. above the level of the sea, but this is 170 meters lower than the highest point of the Rundals scheme. This latter line would also necessitate the railroad running at a height of 3,000 ft. or more, for the much longer distance of 70 kilometers. Among the advantages of the lower line are less risk for snowdrifts and less frequent fogs, and the supply of water appears to be more abundant. Also as regards the inhabitants of the surrounding country, the Aurland line is more favorably positioned than its rivals. The longest distance between the "Salters"—the mountain pastures where the cattle are kept during the the summer time—is only 8 kilometers, while it, on the other line, amounts to 40 to 50 kilometers, and the Salter time is only six weeks on the latter, against ten to sixteen weeks on the former. The soil is also more tractable on the Aurland line; there are, however, a couple of tunnels, through the Klovfjeld, a length of 3.5 kilometers, and through the Grundfjeld, a length of 1.5 kilometers.—*Engineering.*

Blast Furnaces of the United States.—The *American Manufacturer* says: "Our usual monthly table, showing the condition of the blast furnaces of the country on April 1, makes the following showing:

Fuel.	In blast. No.	In blast. Weekly Capacity.	Out of blast. No.	Out of blast. Weekly Capacity.
Charcoal	59	11,337	119	13,210
Anthracite	143	39,477	59	14,314
Bituminous	151	86,709	58	24,375
Total	353	137,523	236	51,899

"As compared with a month ago, this shows a reduction of 2 in the number of charcoal furnaces in blast, an increase of 1 in the number of anthracite, and an increase of 5 in the number of bituminous, making a total increase in the number in blast of 4.

"The capacity for production of the furnaces in blast at the present moment is greater than at any previous time in the history of iron manufacture in this country. The nearest approach to it was on February 1, 1887.

"We estimate the production of pig-iron for the first quarter of 1887, on the basis of our monthly reports, as follows, in gross tons:

Charcoal	127,652	tons.
Anthracite	539,432	"
Bituminous	1,000,952	"
Total	1,668,036	

"This is at the rate of 6,672,144 gross tons a year. The production for 1886 was 5,684,543 gross tons."

Railroad Progress in Central Asia.—Private enterprise appears to be coming to the aid of the Russian Government in the matter of railway development. Two applications have been recently made to the Minister of Railways for permission to extend the Orenburg Railway to Uralsk, in the Kirghiz region. This implies another advance of the locomotive into Central Asia. Until recent years the Russian advance towards India lay through Turkestan in the direction of Orenburg, Tashkent and Cabul. While this movement was in progress Russia pushed her railway system to Orenburg, on the Asiatic border. The movement then changed to the Caspian Sea, io the direction of Krasnovodsk, Merv, and Herat. This led tn the decadence of Turkestan, and the more the advance upon Herat grew into favor the less disposed the Russian Government became to concern itself any further with the extension of the Orenburg Railway to Tashkent. The Orenburg district has, however, developed so much since the completion of the line that sufficient enterprise now exists among the commercial classes to promote the construction of another extension further into Asia. as far as the Cossack town of Uralsk. Two schemes are proposed; one from the Toliminsk station on the Orenburg Railway to Uralsk, a distance of 150 miles, and another from Pokrova, on the Volga, opposite Saratoff, to Uralsk, a distance of 250 miles. In both cases the line would traverse a flat, fertile steppe, like the prairies of America, and the cost in either case would not very much exceed $15,000 a mile. There are no towns of any size between the points, but a considerable trade is done at Uralsk, and the promoters are content to construct and work the lines without a Government subsidy. Last week the Minister despatched a commission to examine the two routes, and whichever be adopted, the European railroad system will make one more advance into Asia. By degrees there is very little doubt that the locomotive will penetrate to Tashkent, although not so rapidly as the Siberian line will push beyond Tobolsk and the Transcaspian line past Bokhara.

New Furnaces of Troy Steel Company.—The new furnaces of the Troy Steel Company situated on Breaker Island in the Hudson River, opposite the works at South Troy, are soon to be put in operation. These furnaces are to furnish material for the Bessemer plant of this company, which was the first operated in this country. It was proposed at first to convey the molten metal from the island on which the blast furnaces are situated to the Bessemer plant on the east shore by boat, but this scheme has been abandoned, and the iron will be run into pigs and will be transported in that form. The furnaces consist of six stores, three furnaces, with necessary engine and store houses, all built upon a foundation of concrete 20 ft. deep.

It is estimated that 3,000 tons of material per day will be required to supply these furnaces. The ore used will be from the Lake Champlain mines, and flux from the vicinity of Fort Edward, N. Y., where a branch track ½ mile long is to be built for its transportation. In order to supply this new enterprise with ore, coal and flux, a branch railroad has been constructed by the Delaware & Hudson Canal Company from a point on the main line about 2½ miles north of Albany to Breaker Island. This branch is about 2 miles in length and consists of 3 spans of 225 ft. each, pin-connected truss bridge across the West Branch of the Hudson, one span 150 ft., riveted lattice, across the Erie Canal, 1½ miles of timber trestle and ¼ mile of embankment.

The construction of this branch was commenced about two years ago, but was not completed until the early part of this winter, owing to delays caused by difficulty in securing right of way, and to damage caused by high water and ice on two separate occasions by which two trestles and six timber piers were carried away at the point where the three spans of pin-connected truss now spans the stream.

The total cost of this branch has been $160,000, and that of the furnaces upward of $2,000,000.

Locomotive Driving-Wheel Tires.—At a recent meeting of the Engineers' Club of Philadelphia, Mr. Theodore Lewis presented a paper on 3 in. *vs.* 4 in. steel tires, from which the following extracts are taken:

"The question as to the desirability of using tires 4 in thick has been before the makers and users of tires for some years past, and there has been a steady increase in the number of roads deciding in favor of the thick tires.

"The average thickness of tires used in this country is probably 3 in., and the argument of those favoring the increase of thickness to 4 in. has been that as a tire is scrapped when worn down to 1¼ in., the cost of this waste metal is carried by a wear of 2¾ in. of metal in the case of the 4 in. tire, while in the case of the 3 in. tire the same amount of waste metal is carried by a wear of 1¾ in.; or, in other words, with a 4 in. tire the amount scrapped, is 45 per cent. of the amount worn off, while with a 3 in. tire it is 71 per cent. If the wearing qualities of both tires are the same, the 4 in. thick tire should be the most economical, and this seemed to be the opinion of those using 4 in. tires, until at the November meeting of the Western Railway Club at Chicago, Mr. G. W. Rhodes presented some figures, showing that on the Chicago, Burlington & Quincy Railroad they had obtained a very slight increase in total mileage from 4 in. tires over that obtained from 3 in. tires. He stated that from an average of 45 sets of 3 in. tires worn out he had obtained a total mileage of 131,627 miles per tire, or 4,250 miles per $\frac{1}{16}$ in. of metal worn off. From an average of 13 sets of 4 in. tires worn out he had obtained a total mileage of 133,956 miles per tire, or 3,252 miles per $\frac{1}{16}$ in. of metal worn off. This makes a difference of only 2,329 in the total mileage of the tires.

"These mileages may appear very small, and it should be said that all the tires were on switching engines, which is severe service. In the same report the mileage made on freight engines is given as 7,500 miles per $\frac{1}{16}$ in. of wear, and that made on passenger engines as 10,000 miles per $\frac{1}{16}$ in. wear.

"It should be stated that in taking these averages the entire 45 sets of 3 in. thick tires were worn out and scrapped, while with the 4 in. tires there were 76 sets, of which but 13 sets were worn out, and it is fair to suppose that if there were differences in the tires these 13 sets were the poorest and that the average of the 76 sets will probably make a better showing for the 4 in. tires. It should be noted that while physical tests from 3 in. and 4 in. tires show very little difference, the amount of work on the 3 in. tire in the process of manufacture is considerably greater than on the 4 in.

"These results have led to the discussion (to be brought up at a future meeting of the Western Railway Club) as to whether the additional weight in the 4 in. tire is not in itself the cause of more rapid wear, and whether it does not result in greater wear of the road-bed and more severe shocks to bridges."